MACHINERY

DESIGN — CONSTRUCTION — OPERATION

Volume 35 DECEMBER, 1928 Number 4

PRINCIPAL ARTICLES IN THIS NUMBER

Finishing Holes by Milling—*By Peter Hall* 241
How Ford Obtains Low Production Costs—*John Younger* 248
Accurate Gaging Methods for Keyways and Keyseats—*By A. J. Cayouette* 250
Current Editorial Comment 258
A Machine Builders' Association—Welded Jigs and Fixtures—Pay Attention to Lubrication
Enlisting the Interest of Your Employes—*By James F. Donahue* 259
Ingenious Mechanical Movements 261
Proportional Form-turning Machine—*By O. S. Marshall* 264
Machining the Breech Mechanisms of Large Guns—*By Charles O. Herb* 267
Developing Men to Assume Responsibility—*By William A. Rockenfield* 271
Furnaces as Production Equipment—*By E. G. De Coriolis* 273
Special Tools for Railway Shops 275
Producing Automobile Replacement Gears—*By Charles O. Herb* 277
Gear Tooth Breakage, Wear, and Noise—*By A. B. Cox* 290
Mechanical Engineers Discuss Motor Drives 294

DEPARTMENTS

Notes and Comment on Engineering Topics 257
Letters on Practical Subjects 283
What MACHINERY'S Readers Think 289
New Machinery and Tools 297

Total Distribution for November, 16,652 Copies

Product Index 302-322 Advertisers Index 325-326

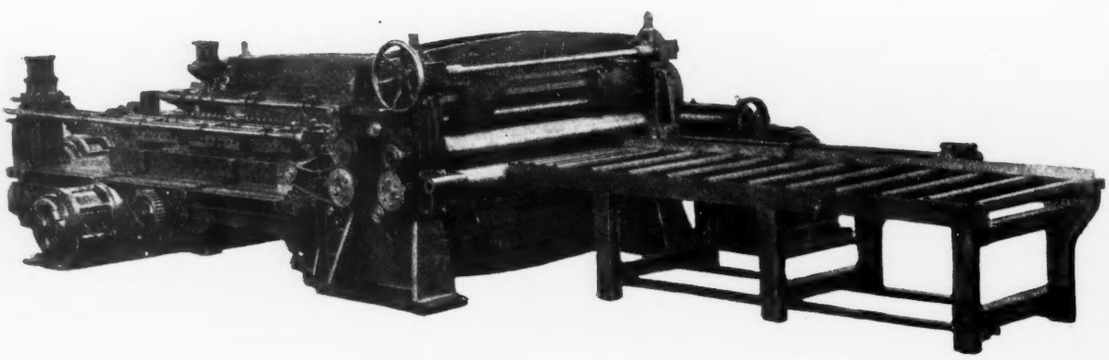
PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS, 140-148 LAFAYETTE STREET, NEW YORK

ALEXANDER LUCHARS, President ROBERT B. LUCHARS, Vice-President EDGAR A. BECKER, Treasurer
ERIK OBERG, Editor FRANKLIN D. JONES, Associate Editor CHARLES O. HERB, Assistant Editor FREEMAN C. DUSTON, Assistant Editor
LONDON: 52 Chancery Lane PARIS: 15 Rue Bleue

YEARLY SUBSCRIPTION: United States and Canada, $3 (two years, $5); foreign countries, $6. Single copies, 40 cents.

Copyright 1928 by The Industrial Press. Entered as second-class mail matter, September, 1894, at the Post Office in New York, N. Y., under the Act of March 3, 1879. Printed in the United States of America.



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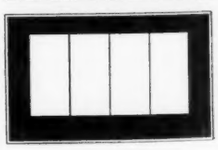

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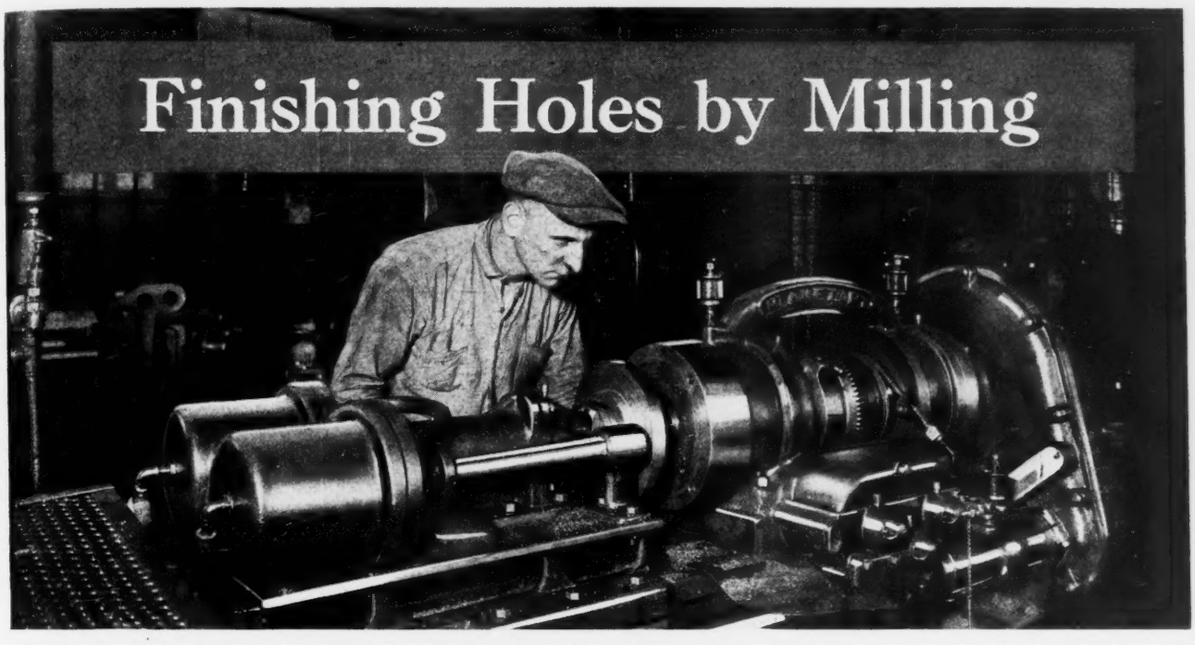
MACHINERY

Volume 35 NEW YORK, DECEMBER, 1928 Number 4

Finishing Holes by Milling



A Method by which Several Bores of Various Diameters may be Milled at the Same Time that Facing or Threading Cuts are Taken

By PETER HALL, President, Hall Planetary Co., Philadelphia, Pa.

MANY parts, as, for example, automobile hubs, have several bores of different diameters and a number of front or back faces or shoulders that must be finished within close limits of accuracy relative to one another. All such surfaces of numerous parts can be finished simultaneously by milling in the "Planetary" milling machine built by the Hall Planetary Co., Philadelphia, Pa. External surfaces of various diameters and contours can also be finished by milling in this machine, but the present article will deal entirely with the machining of holes and adjacent shoulders and faces.

Threads may be milled at the same time that other milling cuts are taken; however, in order to mill threads simultaneously at several different points on a part, the threads must all be of the same lead and of the same hand. Tapered holes can be milled and threads produced in such holes.

"Planamilling" and "Planathreading"

The principal feature in the operation of this machine is that the work always remains stationary, while the cutters revolve on their axis and at the same time make a planetary movement around the surfaces being machined. In finishing internal surfaces, milling cutters only about 20 per cent smaller in diameter than the surface being machined are employed. For external surfaces, the cutters are arranged to completely surround the work. The diameters across the cutting edges are only about 20 per cent greater than the diameters of the surfaces milled by them. Owing to the close approximation between the diameters of the cutters and the surfaces machined by them, several of the cutter teeth are always in contact with the work.

The term "Planamilling" is applied to all milling operations performed in this machine, with the exception of thread milling. The latter is designated as "Planathreading." The razor-like easily burred edge found at the start of threads produced by ordinary methods is automatically removed in cutting either external or internal threads by this method. The result is a smooth "Planetary Approach" in which the thread does not reach full

PETER HALL was born in Philadelphia, Pa. He was educated in a private school of that city and later took a business college course. Between 1893 and 1895 he was employed in Chicago, Ill., by the Edison Co., General Electric Co., and the Chicago & Northwestern Railway, being engaged in the manufacture of motors, meters, etc., in the upkeep of street car motors and controllers, and in the maintenance of factory lighting systems. From 1896 to 1900, he was with the Bell Telephone Co. in Philadelphia. Between 1900 and 1914, Mr. Hall manufactured marine gasoline engines in partnership with his brother. Many races, including one to Bermuda in 1909 and one to Havana in 1910, were won by boats in which Hall engines were installed. During the war, Mr. Hall discontinued the manufacture of marine engines and developed machinery for producing munitions. At that time the principles of the Hall "Planetary" thread milling machine were conceived and incorporated in a small fixture that was attached to an engine lathe for milling threads in the nose of shells. This principle was later developed into the thread milling machine now manufactured by the Hall Planetary Co., of which Mr. Hall is president.

height until it has attained the complete cross-sectional shape.

How the Planetary Movement is Derived

In milling either internal or external surfaces, the cutters are carried by a large hollow spindle, which is assembled in two eccentric sleeves. This hollow spindle is revolved on its own axis at the highest speed permitted by the character and material of the work. While it rotates, the eccentric sleeves first move the spindle a certain amount radially so as to feed the cutters to depth, and then the sleeves impart the planetary movement to the spindle to carry the cutters around the surfaces being milled.

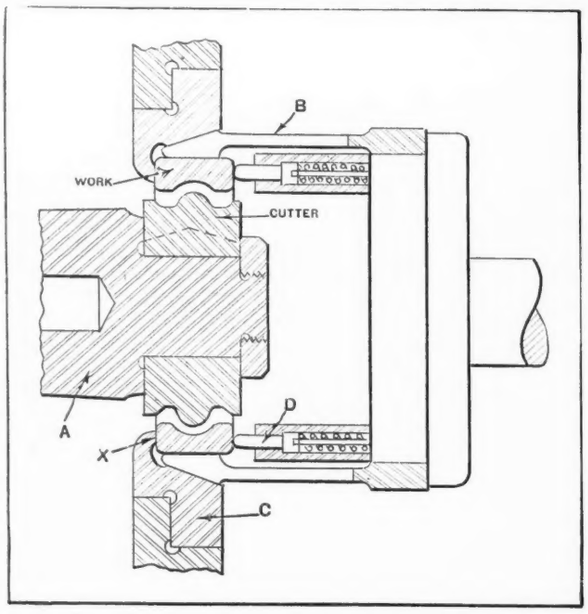


Fig. 1. Form-milling the Raceway of a Ball Bearing Part

At the end of a "Planamilling" operation, the rotation of the inner sleeve is reversed for a small part of a revolution, so as to bring the spindle and cutters into the neutral position, ready for loading a new piece of work into the machine. The hollow spindle and cutters continue rotating while in the neutral position, and after the work has been reloaded, the operator moves a single lever to start the radial and planetary movements.

In milling threads, the hollow spindle and the cutters are moved longitudinally an amount equal to the thread lead, during the planetary movement. At the end of the thread milling operation, both the inner and outer sleeves in which the hollow spindle is assembled make a complete backward revolution, after the cutters and spindle have been returned to the neutral position, so as to move the cutters axially an amount equal to the thread lead.

Cutters and Chucks are Designed to Suit the Individual Job

Solid cutters are used for milling internal surfaces of small diameters, while cutter-heads with inserted "button" cutters are employed for milling medium- and large-sized holes and for most external surfaces. The inserted "button" cutters are small circular formed cutters which can be ground repeatedly and readjusted as they become worn. They are ground to the rake most suitable for the material to be cut. By adjusting them in the cutter-heads, the clearance may be altered as desired.

Every cutter is designed to meet the requirements of the particular part to be machined. The material to be cut is taken into consideration, the feeds and speeds to be used, etc. Cutting speeds up to 250 feet per minute are used on some mild steels. Such a speed is possible principally because of the design of the cutting edges on the milling cutters. The hook of the cutting edges is often as much as 25 degrees, and the back angle ranges from 4 to 25 degrees. Cutting oil is delivered copiously to the cutters under pressure to wash the chips out of the flutes and to keep the cutters cool. As much as 40 gallons of cutting oil is fed per minute to some of the larger cutters, such as are used in milling 4 threads per inch on oilwell tool joints made of 0.50 per cent carbon steel.

Chucks are also designed to suit the individual piece. They should be constructed to hold the work rigidly and in such a manner that it will not be distorted either from the gripping pressure or from the action of the cutters. Only finished surfaces should be used for locating purposes, and surfaces likely to spring should be supported close to the cutters. Pneumatically operated chucks are employed in many instances to expedite reloading and to reduce fatigue of the operator.

Parts can be readily milled in the "Planetary" milling machines to specified dimensions within plus or minus 0.001 inch, and all parts considered in this article are machined to that degree of accuracy. Concentricity of all bores produced in a part, whether plain or threaded, is one of the principal features of this milling method. Another advantage is that threads can be produced accurately in relation to a keyway or shoulder. In all operations here shown, the production is one piece per minute unless otherwise stated.

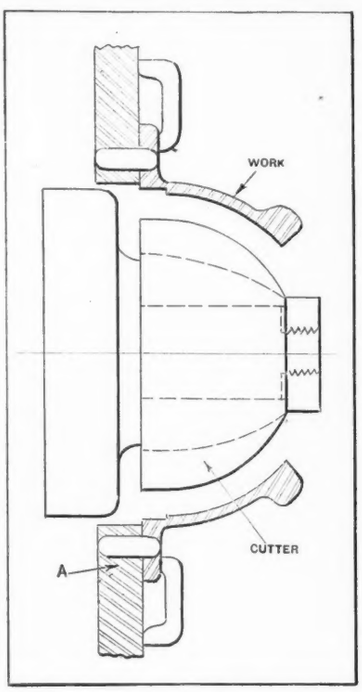


Fig. 2. Milling a Spherical Seat

The accuracy obtained in these milling operations is a result not only of the fundamental principles upon which the machine is based, but also of the various details of construction. There are no sliding ways or gibs, and all chucks are so designed that the work is directly connected to the head of the machine; the bed holds only that part of the chuck which grips and releases the work. The work is moved into position over the cutter and then clamped securely for the operation. (In external milling and threading operations, the work is

of course, moved within the cutter.) Constructed in this manner, the machine is often capable of finishing work to size within 0.00025 inch.

Milling Outer Races of Ball Bearings

Internal surfaces of ball bearing races may be milled in the manner illustrated in Fig. 1. The part is form-milled by a cutter as the cutter is fed to depth and then revolved once around the part in the planetary manner previously described. This cutter is of the solid type, and is mounted on an arbor *A*, which is held in the hollow spindle of the machine. Coolant is delivered under pressure through the hollow center of the arbor and thence through vents direct to the cutter teeth.

The bearing race is held in a split collet chuck *B*, which is attached to a head that is withdrawn toward the right from the cutter for reloading. After a race has been slipped in place, the head moves collet *B* toward the left into the tapered seat of ring *C*, which forces the collet firmly on the race. Before this action occurs, however, the front side of the work comes in contact with shoulder *X* of ring *C*. It is thus held firmly between this shoulder and several spring plungers *D*.

Two operations, one roughing and one finishing, are taken on this part, which is made of alloy steel. In the roughing cut, approximately 1/8 inch of stock is removed. In taking the finishing cut, a very smooth surface is not required, as the part is ground to size after being hardened. The maximum diameter machined in this operation is approximately 3 5/8 inches.

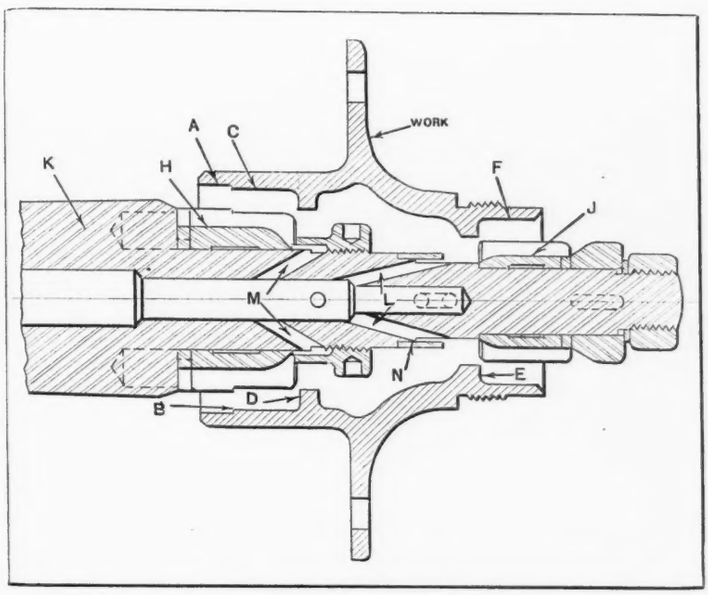


Fig. 3. Simultaneously Milling Three Bores and Three Shoulders of Automobile Wheel Hubs

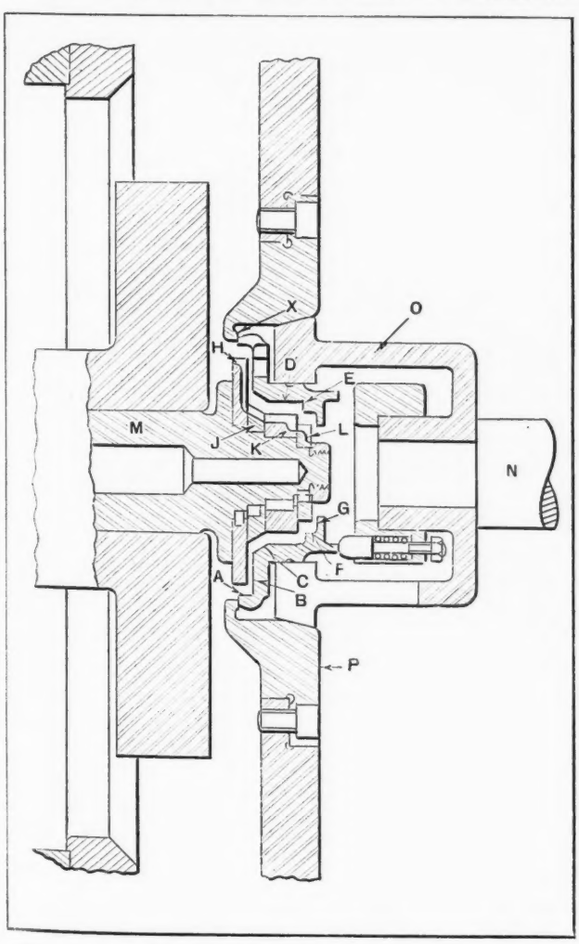


Fig. 4. An Operation in which Seven Internal Surfaces are Milled at One Time

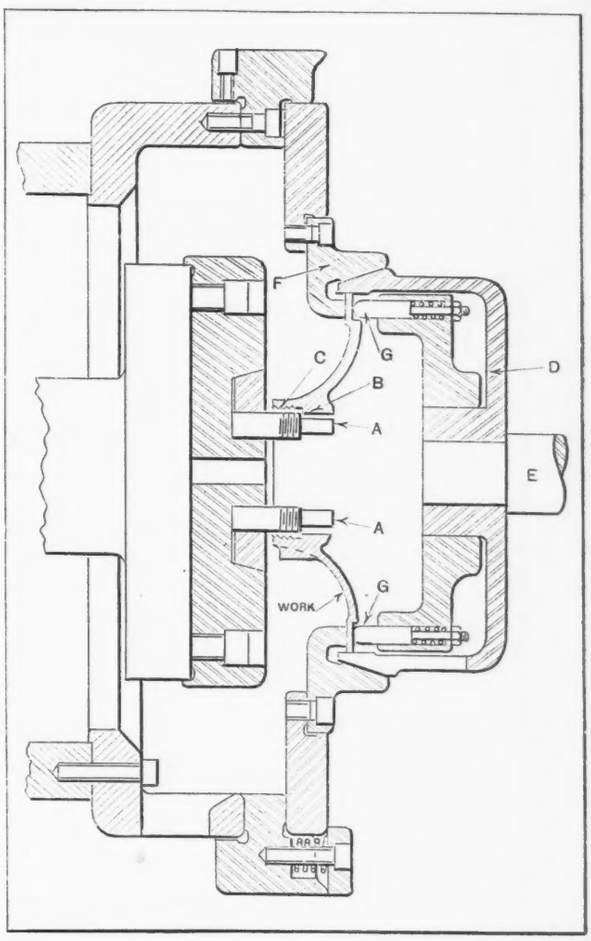


Fig. 5. Hole-milling and Thread-milling Operation on a Differential Carrier

Finishing a Concave Automobile Part

Another form-milling operation is shown in Fig. 2, in which the internal surface of an automobile drive-shaft universal joint is milled spherically. Roughing and finishing cuts are taken on this steel forging with a single chucking of the work. At the end of the roughing cut, a small lever is moved to feed the cutter toward the work about 0.005 inch. The machine is then started for the finishing cut. For the operation, the part is clamped to housing *A*, which remains in a stationary position on the bed of the machine. The cutter is also of the solid type. The maximum diameter of the surface machined is about 4 1/2 inches.

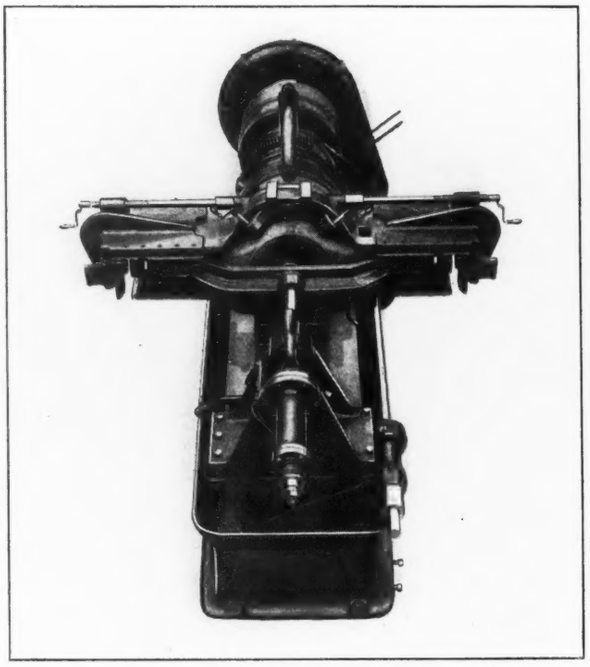


Fig. 6. "Planetary" Milling Machine Engaged in Milling Two Large Holes, and the Adjoining Faces, of Automobile Rear Axle Housings

Taking Six and Seven Cuts Simultaneously

Automobile wheel hub forgings are milled internally at both ends by means of the equipment illustrated in Fig. 3. The operation consists of milling surfaces *A*, *B*, *C*, *D*, *E*, and *F*. Solid cutters *H* and *J*, mounted on arbor *K*, machine all these surfaces concentrically in one planetary movement. As in other operations in the "Planetary" machine, coolant is copiously supplied to both cutters through the hollow arbor and vents *L* and *M*. A deflector ring *N* throws the coolant on the teeth of cutter *J*. This coolant is delivered at a sufficient pressure to carry away all chips from the cutter teeth. The work is clamped to a housing, which is positioned in a stationary manner on the machine bed.

The equipment illustrated in Fig. 4 was designed for simultaneously finishing seven surfaces, *A*, *B*, *C*, *D*, *E*, *F*, and *G* of an automobile rear wheel bearing. All these surfaces are milled by cutters *H*, *J*, *K*, and *L*, which are assembled on arbor *M*. At the beginning of this operation, the revolving cutters are fed into the work at an angle of 45 degrees, so as to start the cut gradually on the comparatively large faces *B*, *E*, and *G*.

Loading of the work in this operation is speeded up through the use of pneumatic equipment. Rod *N* is connected to an air cylinder, and chuck *O* is moved backward for reloading and forward for the operation by simply manipulating an air valve. When the chuck is withdrawn, a previously finished surface of the work is seated in the front end, and then when the air cylinder forces the chuck into the tapered seat of fixture *P*, the chuck is forced firmly on the work. Before this action occurs, however, the front edge of the work comes in contact with shoulder *X* of the fixture. Fixture *P* is mounted on the bed of the machine, but is also connected to the stationary headstock housing. The

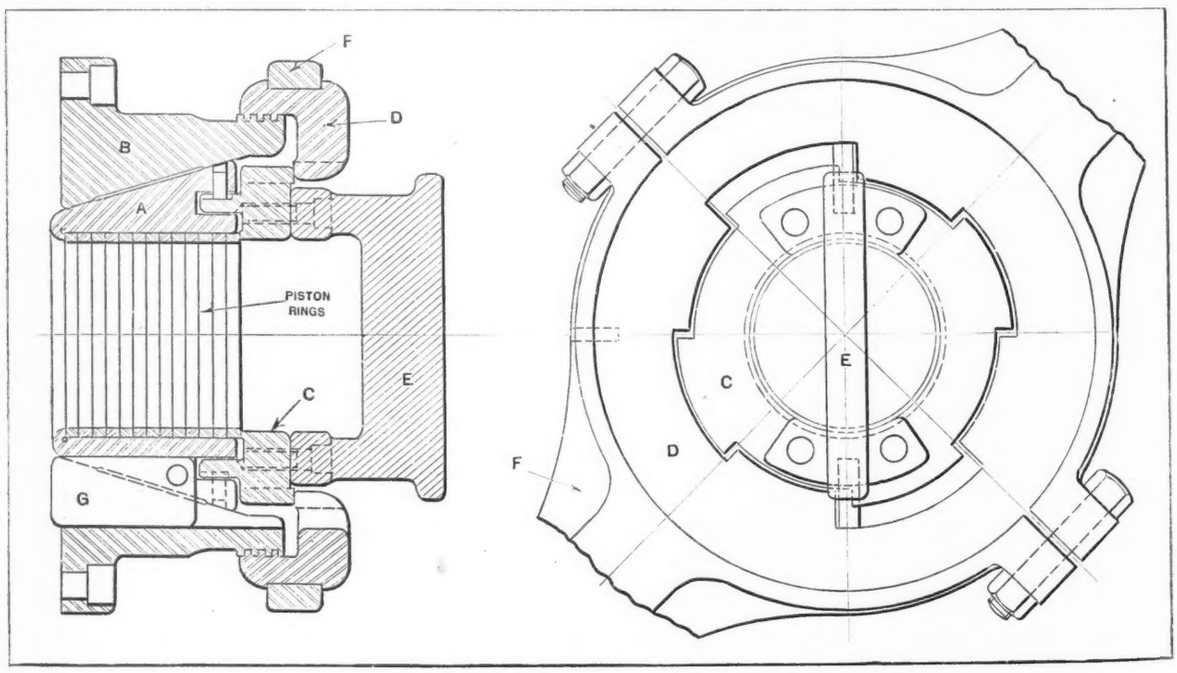


Fig. 7. Fixture of Unusual Design Employed in Simultaneously Milling the Bore of Thirteen Piston-rings

largest surface of the work machined in this operation is approximately 5 1/4 inches in diameter.

Milling Piston-rings in Large Quantities

Thirteen piston-rings are milled internally at the same time by means of a solid type of cutter, while held in the fixture shown in Fig. 7. These rings are finished in one operation at the rate of thirteen per minute or one ring every 4.6 seconds.

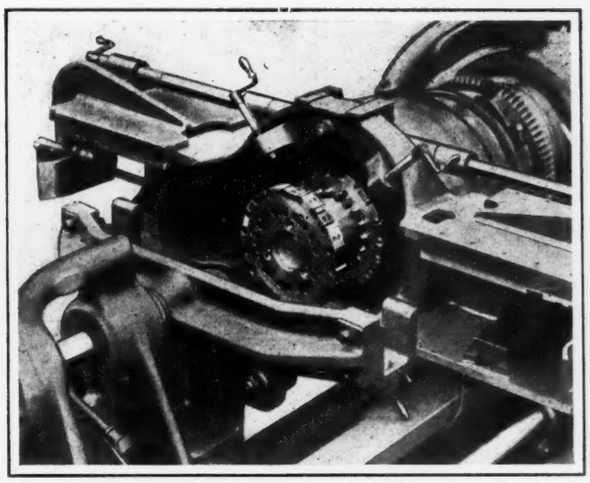


Fig. 8. Close-up View of the Work-holding Fixture and Cutter-head Employed in the Operation Shown in Fig. 6

The thirteen rings are loaded into a split retainer *A* when the latter is removed from the fixture housing *B*, several retainers being employed so that one can be loaded while another is in the machine. The retainer is fastened to a ring *C*, which has four lugs around the periphery, as may be seen in the end view, of a size that permits them to be readily slipped through corresponding slots in nut *D*. A handle *E* attached to each retainer facilitates inserting it into housing *B* for an operation and removing it after the operation has been performed. Retainer *A* is swiveled into a 90-degree position on ring *C* so that the piston-rings can be loaded from the back.

In placing a loaded retainer in housing *B*, the retainer unit is so held that the lugs of ring *C* can be entered through the slots of nut *D* in somewhat the same manner that the breech-block of a cannon is inserted in the breech bushing. When ring *C* has been completely passed through the nut, casting *F* is rotated by hand to tighten nut *D* on housing *B*, and as the nut is turned, the lugs between its slots pass over the lugs of ring *C* and force this ring forward. As ring *C* is advanced, it clamps the tapered surface of the retainer against the corresponding seat of housing *B*. The piston-rings are thus firmly gripped between a shoulder on the retainer and a shoulder on ring *C*. Two keys *G*, which are fastened to the retainer, are entered into slots in housing *B* when the retainer is loaded into the housing. These keys prevent the retainer from revolving with nut *D* and so guide the work-holder that the work does not hit the cutters during loading and unloading.

Machining Rear Axle Housings

Most automobile rear axle housings have two large central holes, which must be machined accurately as regards diameter and alignment, and two large faces adjacent to the holes which must be machined parallel with each other within close limits. Both of these holes and the two faces are

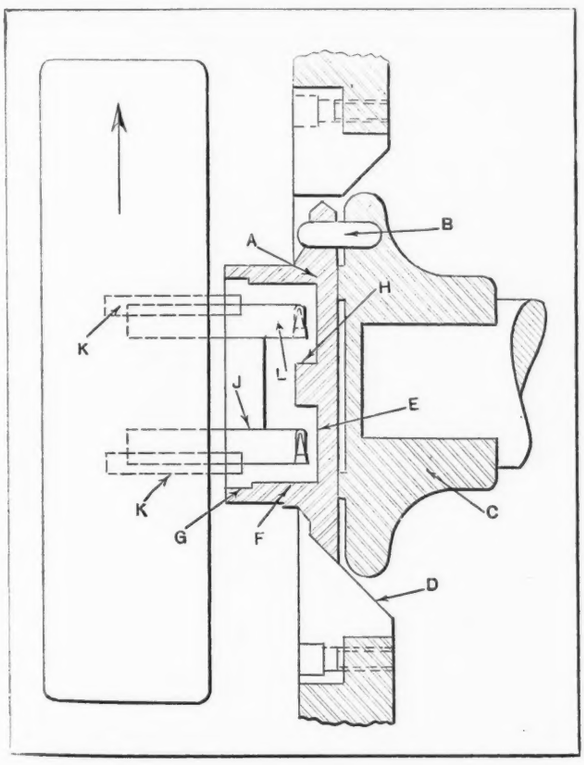


Fig. 9. Operation in which Boring, Facing, and Turning Cuts are Taken on a Shock Absorber Part

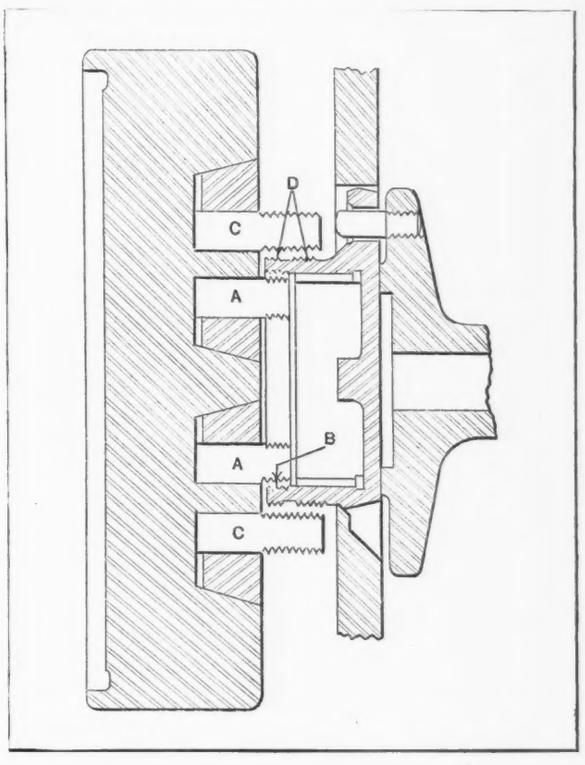


Fig. 10. Tool Equipment for Cutting External and Internal Threads on the Part Shown in Fig. 9

machined in one operation on the "Planetary" machine illustrated in Figs. 6 and 8.

The rear axle housing is held in a large fixture, mounted directly on the headstock of the machine. This fixture holds the housing rigidly while the combination face- and hole-milling cutter seen in Fig. 8 goes through the planetary movement previously outlined to mill the holes and the two faces.

Prior to the actual operation, the housing is placed on two arms of the tailstock. These arms are then moved forward through the action of an air cylinder to carry the housing into the fixture. Next the operator turns a screw having right- and left-hand threads to bring two locating plugs into contact with the end bores of the housing and thus centralize the part. Two small air cylinders then push hardened wedges into contact with the spring pads on the housing for locating purposes. Four hand-operated screws at the center of the fixture are next brought into contact with the housing, and finally the ring that carries them is bound fast to the fixture by means of two nuts. During the machine cycle, coolant is turned on and off automatically in the standard manner.

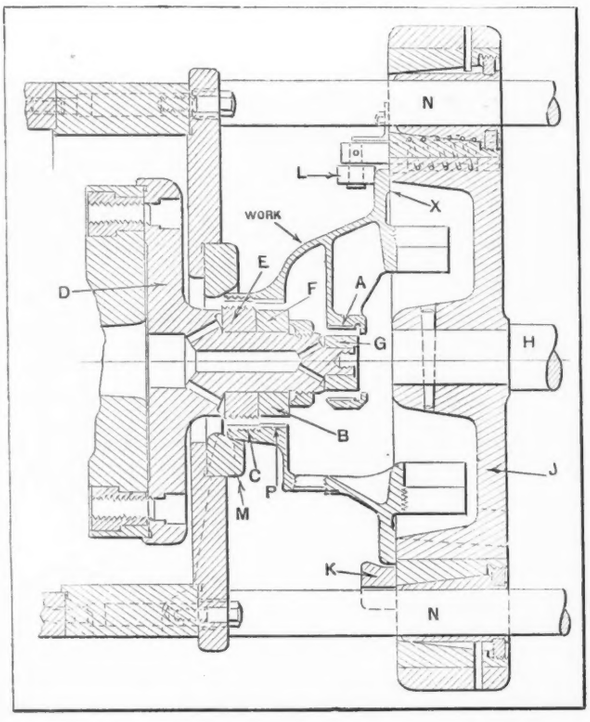


Fig. 11. Equipment for Milling Two Bores and Threading a Third, on Automobile Differential Carriers

The construction of the cutter-head employed in this operation may be clearly seen in Fig. 8. Eighteen formed cutters are assembled around each disk portion of the cutter for finishing the housing bores, and a similar number of cutters extend from one side of each disk for milling the adjoining housing face. Vents extending from the center of the cutter-head deliver coolant to each cutter. The cutter-head weighs about 150 pounds.

Hole- and Thread-milling at the Same Time

Two hole-milling cuts and one thread-milling cut are taken simultaneously on automobile differential carriers with the equipment shown in Fig. 11. The operation consists of milling bores *A* and *B* in alignment with each other and cutting threads *C*. The cuts are taken by means of three solid type cutters, shown diagrammatically at *E*, *F*, and *G*, which are mounted on cutter-head *D*. The illustration actually shows equipment provided for finishing two differential carriers that are slightly different in construction. Holes *A* and *P* of one carrier are approximately 2 1/4 and 4 1/4 inches in diameter, respectively. Both parts are malleable iron castings.

The operations on these differential carriers are expedited through the use of pneumatic equipment for chucking the part, rod *H* being a piston-rod which extends into an air cylinder at the right-hand end of the machine bed. In loading a casting on head *J*, when this head is in the loading position, the casting is loosely attached by resting it on block *K* and slipping it under roller *L* into the position illustrated. Then when head *J* advances, the work is centralized in relation to the cutters as it is forced into locating plate *M*. Pilot-bars *N* maintain alignment between head *J* and the housing in which plate *M* is assembled.

Prior to this operation, face *X* of the differential carrier is finished in another machine to provide an accurate bearing surface. Roller *L* is fastened to a spring-actuated stud, so that it can readily adjust itself to compensate for irregularities in the castings.

Fig. 5 shows a somewhat similar operation on another differential carrier in which a cutter-head is employed that is provided with sixteen circular formed cutters *A* of the "button" type. These cutters simultaneously mill surface *B* and thread-mill surface *C*. Chuck member *D* in which the part is held is moved into the loading and operating positions by means of air equipment which functions through rod *E*. The work is carried forward by member *D* until it comes in contact with a circular shoulder on part *F*, being then held firmly in contact with this shoulder by a number of spring-actuated plungers *G*. Bore *B* is approximately 3 5/8 inches in diameter.

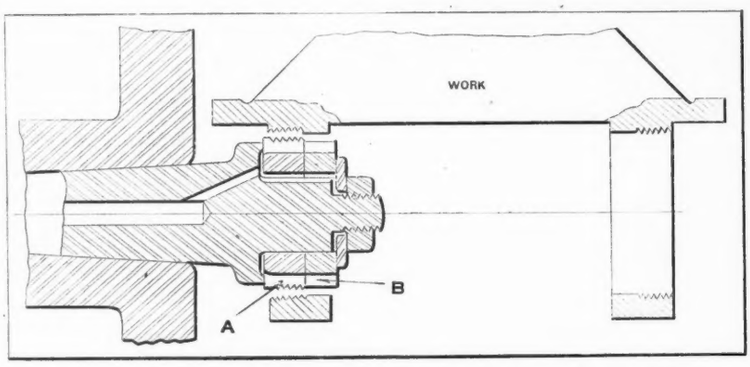


Fig. 12. One of Two Methods Employed for Plain- and Thread-milling the Cross-bores of Differential Carriers

Machining the Cross-bores of Differential Carriers

The cross-bores of differential carriers can be plain- and thread-milled one at a time or simultaneously. Fig. 12 shows typ-

ical tooling employed for the first of these methods. The cutters are indicated at *A* and *B*. After one bore has been finished, the work-fixture is indexed 180 degrees, and the second bore is then plain- and thread-milled in alignment with the first. The threads are machined concentric with the plain cross-bore surfaces and at right angles to the bores machined as illustrated in Fig. 11.

In machining both cross-bores at one time, a machine with two movable heads is employed. The differential housing is bolted to a holding plate, and both heads slide toward the work to bring the cutters within the bores to be finished. Then the cutters go through a planetary movement to machine the plain and threaded surfaces on both bores simultaneously.

Milling Internal and External Threads Simultaneously

A method of taking several cuts on internal surfaces of automobile shock absorber parts is shown in Fig. 9. As illustrated at *A*, this part is assembled on pins *B* of a pneumatically actuated holder *C* for the operation, the holder, of course, being withdrawn to the right for loading purposes. The part is accurately located by forcing a finished tapered seat against the tapered hole in casting *D*.

In the operation, surface *E* is partly faced by ten tools *J*, and surface *F* is bored by the same tools as the tool-head advances the cutters into the work at an angle of 45 degrees. Simultaneously, ten cutters *K* finish surface *G* and face the adjacent shoulder to the specified dimension from surface *E*, within plus or minus 0.0005 inch. While these cuts are being taken, the facing of surface *E* is completed by five tools *L*, and boss *H* is turned by the same tools.

After this shock absorber part has been machined as described, threads are cut simultaneously on internal and external surfaces, as indicated in Fig. 10, the part being located for this operation in the same manner as before. "Button" type formed cutters *A*, of which there are ten, arranged around a circle, mill internal threads *B*, while similar cutters *C* produce threads *D*. The diameter of the external threads is about 3 3/16 inches, and that of the internal threads, 2 3/4 inches. The number of threads per inch, both external and internal, is 18 and both threads are right-hand. In both operations on this part, the production is two pieces per minute, floor-to-floor time.

* * *

According to the Bus Division of the American Automobile Association, the average cost of operating buses in the United States is 1.1 cents per seat per mile, compared with 2.6 cents per seat per mile for private automobiles.

Which Way Is Business Headed?

Each year, in the January number, MACHINERY publishes the opinions of prominent executives in different branches of the machine-building and metal-working industries on the prospects of business for the coming year. This year a comprehensive review will be included on the business outlook in the machinery field as the result of answers to 1400 questionnaires sent by MACHINERY to the largest machine building, metal-working, and machine-using firms in the country. A year ago MACHINERY predicted, on the basis of the survey made, that there would be a steady, healthy business in 1928, showing improvement over 1927, with a total volume possibly 5 or 10 per cent greater than that for the year just ended. It was also stated that the presidential election would probably have no noticeable effect on business. The experiences during the past year have proved that these conclusions were correct.

WHEN JIGS AND FIXTURES PAY

At the Machine Shop Practice Division session of the annual meeting of the American Society of Mechanical Engineers, to be held in the Engineering Societies Building Monday, December 3, at 2 P. M., Joseph W. Roe, professor of industrial engineering at New York University, will present a remarkably complete paper on the principles of jig and fixture design.

The paper will give a brief historical review of the development and use of jigs and fixtures, and will present the economic principles involved in the use of this class of equipment. Formulas will be given for the first time in the history of this branch of machine design, by means of which it is possible to determine in advance, with considerable accuracy, the savings that may be expected from the use of jigs and fixtures when all the economic factors involved in their design, making, and use, are taken into consideration. The paper will then proceed to outline the general principles that must be taken into account in designing jigs and fixtures, giving specific rules, illustrated by diagrammatic drawings, relating to the details of the design of this type of tooling equipment.

Another valuable feature of the paper will be the complete bibliography appended, covering all the important articles and books that have appeared within recent years on jig and fixture design. A complete copy of the paper may be obtained by addressing the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

* * *

MEETING OF THE AMERICAN MANAGEMENT ASSOCIATION

The American Management Association held its annual convention at the Palmer House, Chicago, Ill., November 12 to 16. An extensive program was provided, and a great number of papers were read, covering such subjects as compensation of executives; budgeting; research activities and organization; research methods; functions of boards of directors; board committees and officers; old-age pensions; employe health activities; and office management. A paper of particular interest to the machine tool industry was read by Ernest F. DuBrul, general manager of the National Machine Tool Builders' Association, on "How a Code of Business Practice Was Established in the Machine Tool Industry." The National Machine Tool Builders' Association has translated the code of business ethics adopted by the United States Chamber of Commerce into concrete terms and practices of the industry. This code should be of interest to every branch of industry.

How Ford Obtains Low Production Costs*

By JOHN YOUNGER, Professor of Industrial Engineering, Ohio State University, Columbus, Ohio

BY the application of certain laws of manufacturing management, the Ford Motor Co. has obtained very low production costs. These laws were applied by the company long before they had been put into concrete form by L. P. Alford, who formulated them in a paper presented before the American Society of Mechanical Engineers in 1926. Summarized briefly, the principles on which the success of the Ford Motor Co. is based are:

(1) Concentration on a single product. (2) Keeping each article distinct. (3) The extensive use of conveyor systems. (4) Subdividing work so that each worker has only one or a very few operations to perform. (5) Providing the necessary quantity of material of the specified quality at the required time and place. (6) Assigning a definite amount of work to each man to be done in a given time. (7) Wage payment system based on the straight day-rate. (8) Acquirement of definite and reliable sources of raw materials. (9) Reduction of inventories of materials in stock and in process. (10) Foregoing intermediate profits on processes between raw materials and finished product. (11) Keeping materials and parts in rapid motion to assure quick turnover. (12) Using machine tools that give the lowest production cost and require the least manual control. (13) Employment of machines that perform several operations simultaneously with the same amount of labor as for one operation. (14) Sending machines to the overhaul shops at regular intervals. (15) Recognition that the obsolescence factor is more potent than depreciation of machines by wear.

Some years ago there was much controversy as to the merits of single-purpose versus standard machine tools. In the Ford plant, this question is answered in a simple manner. The machine that is least costly to operate under the conditions of manufacture met with in a given plant, consideration being given to all the elements of cost, is the machine to use. Machine tools are not only a means of fabricating a product, but also a means of lowering costs, and should be studied with this in view. Mr. Ford holds that "hiring two men to do the work that can be done by one is a crime against society." If one machine and one operator can do several operations simultaneously in the same floor space that would be occupied by several machines, such a machine is likely to be the one selected, because it saves in the ultimate cost of the product.

The Ford Payment Plan is Based on Straight Day-rate

One of the secrets of the low production costs of the Ford Motor Co. is the use of conveyors as pace setters. The highest efficiency in the utilization of materials is obtained by providing the necessary quantity of the proper quality and condition at the required time and place. Conveyors furnish the material both at the required time and place, and are therefore not only handlers of materials but also pace setters.

The use of conveyors leads directly to a consideration of the Ford system of wage payment. This is based on the idea that the average worker accomplishes most when assigned a definite amount of work to be done in a given time. The phrase "in a given time" is the basis of the solution of the wage problem in a mass-production plant. The Ford Motor Co. does not pay its men on the piece-work, premium, bonus, or any other system than the straight day-rate. The men must, however, positively accomplish the given task in a given time. The conveyor system, or direct handling, takes care of this.

The piece-work basis offers a premium in extra wages for doing the work in less than standard time. It is not "in a given time" but "in less than a given time" that counts. The Ford organization does not want this. If a worker does his operation in less than a given time, he creates a vacuum behind him and a surplus in front of him. Both results are inimical to decreased costs of production. If a man has the incentive provided by the conveyor and the foreman, why should a complicated mechanism of time-study men and wage and cost departments be set up to give a further incentive, which is not only unnecessary but harmful? A needless saving of time in fabrication is as serious as a needless excess of material.

No Intermediate Profits are Taken

Another Ford policy is that of constantly reaching back to the source of raw materials. This has an important bearing on cost reduction. Coupled with this policy is that of constantly trying to reduce inventories of material in stock and in process. The savings resulting from the latter practice are obvious. The former policy may seem difficult to apply; yet, when the situation is analyzed, it will be found that the small foundry which puts in its own pattern shop is, in its small way, reaching out toward the Ford ideal.

A most important policy that is also combined with the foregoing is that the Ford Motor Co. takes no intermediate profits. Only when the finished unit is assembled into a car is a profit taken. This has far-reaching effects. Suppose the conventional plant purchases its steel bars from a mill that buys its pig from blast furnaces, and that the furnaces, in their turn, purchase from the iron ore company. At each step let us suppose a 10 per cent profit is taken. We thus arrive at a pyramiding of costs. In the shops in our industry we take no profit when we move a job from the drill press to the milling machine or at any intermediate stage until the

*Abstract of a paper presented at the production meeting of the Society of Automotive Engineers at Detroit, November 22 and 23.

article is finished. This theory and policy are applied in the Ford organization from raw material to finished product, with resultant lower costs.

Quick Turnover of Inventory Reduces Costs

As previously mentioned, the Ford Motor Co. keeps its material inventories low. It also follows the policy of keeping the material in rapid motion, thereby getting a quick material turnover. In theory, material lying idle or at rest is regarded as just so much money not earning anything, or as so much labor at a standstill. Executives in many plants recognize this factor of loss, but few pay as much attention to it as the Ford Motor Co., which makes strenuous efforts to keep actually in process the material that is nominally in process, so that virtually all the material inventory may be said to be always in transit.

It is exceedingly difficult to calculate the turnover of Ford's material as a whole. Possibly a true result could be obtained only by calculating the turnover of each department separately, which would be a monumental task. It is sufficient to make a rough approximation. Based on the pace-setting mechanisms and the control of material, we may well take a figure of about 50 turnovers per year. To substantiate this figure, we can take a specific example in which a record was made under observation. Iron ore was melted in the blast furnace and run into pig. The pig, still warm, was charged into the cupola, thence run through the foundry and, as a casting, moved into the machine shop. Thence, through the various fabrication steps, it reached the assembly conveyor and took its final place in the completed product. The elapsed time was 30 hours.

A few years ago the company had a turnover of 15 times each year. In other words, each year it took a profit 15 times on its raw material. Today, it can take a profit 50 times, or apply the saving toward a reduction in factory costs.

Machine Tools as Factors in the Cost Reduction Plan

Some years ago there was much controversy as to the merits of specialized versus standardized machines. Henry Ford has but one answer to this problem. The machine that is least costly to operate, consideration being given to all phases of operation, is the one he uses. He does not regard machine tools merely as a means of fabricating his product; he looks upon them as a means of lowering costs, and studies them constantly with this in view. No machine tool of a different type or model is purchased unless it can be proved conclusively that it lowers production cost. Fully automatic machines that require the minimum of labor control are acquired, as far as possible. Mr. Ford holds that "hiring two men to do work that can be done by one is a crime against society." If one machine can do several operations simultaneously in the same floor space occupied by several machines and with but one attendant, the purchase of the machine is indicated, because it saves in ultimate cost of the product.

Machines are Overhauled at Regular Intervals

Ford machine tools are not "babied" during their use. The factor of obsolescence is today more potent than that of depreciation by wear. Machines should become worn out simultaneously with their obsolescence. This policy also undoubtedly leads to lowered production costs. Incidentally, it is worth noting how the company utilizes standardized periods in determining when a machine is ready for the overhaul shops. A new machine, when broken in, will perform its work in a standard period with normal maintenance effort. As it wears, greater effort will be necessary to maintain the accuracy of the work, and this care or effort will require more time. There is a natural tendency for the standard time to be over-run; but before this happens, the machine is removed from the line to be overhauled.

Few companies seem to recognize this correlation between standard time and wear, and consequently the machine is kept in use beyond the economic point. Attention to this detail undoubtedly will result in a saving in production costs.

Saving Costs by Performing Several Operations Simultaneously

Finally, we come to the use the Ford Motor Co. makes of the principle of "simultation." This principle is worthy of observance, as it has effects in the direction of economy that are so far-reaching in mass production, I believe, as to have an important bearing on American prosperity. To E. P. Blanchard should go the credit for first elucidating this principle and giving it a name. The law of simultation may be expressed thus: "Performing two or more processes simultaneously and in harmony, on one machine, with the same amount of labor as for one operation, leads to a maximum economy."

For the same expenditure on fixture design, for the same or a little greater machine expense, and for the same labor cost, it is possible to have a man and a machine working 100 per cent of the working hours, with resulting economies that are surprising. The principle can be applied to machines as well as to men, and is embodied in many modern machine tools. To carry the principle to its fullest extent, every individual operation in a modern mass-production enterprise, whether it is handling, fabrication, or assembly, should be in process simultaneously and in coordination throughout the plant.

Much has been said in favor of piecework and bonus systems for reducing production costs. It is, therefore, interesting to note that the Ford Co., which has a world-wide reputation for low-cost production, does not apply any so-called "incentive" payment. The Ford Co., pays a straight hourly rate, believing that the average worker accomplishes most when assigned a definite amount of work to do in a given time. The phrase "in a given time" is the basis of the success of the wage system used at the Ford plant. The men must accomplish their work in a predetermined period. In most instances, the conveyor systems, accurately timed to correspond with the operations to be performed, take care of this. Thus the use of time-study men to determine piece-rates, and special departments for calculating piece-work or bonus earnings, become unnecessary.

Accurate Gaging Methods for Keyways and Keyseats

By A. J. CAYOUETTE, The White Co., Cleveland, Ohio

MANY types of gages may be used for gaging keyways and keyseats, and for that reason much time is wasted in the shop and tool or gage designing departments in deciding upon the type of gage to use. The result has been an accumulation of many types of gages, which obviously is not an economical practice. Standardization of keyway and keyseat gages and methods of gaging will remedy this condition, and it is with the idea of assisting or creating interest in this line of standardization that the present article has been prepared. The gages and methods described have proved successful under regular production conditions on work demanding a high degree of accuracy.

Gaging Keyways in Cylindrical Holes

Keyways in straight cylindrical holes, such as shown in Fig. 1, may be gaged with either of the two types of gages shown in Fig. 3. The type shown at *A* is for gaging the width, depth, and radial location of the keyway with relation to the center of the hole. When production methods insure the correct radial position of the keyway, the type of gage shown at *B* is practical and less expensive.

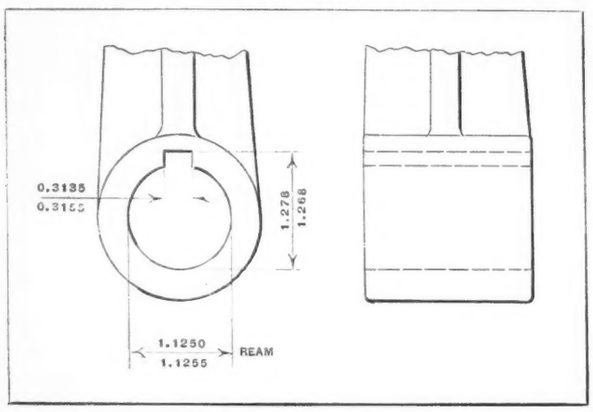


Fig. 1. Method of Dimensioning Keyways in Straight Cylindrical Holes

The construction of this gage is simplified by circle-grinding about the center line of the gage. The gage is oscillated about this center line when grinding the surface that gages the maximum, 1.278 "No Go," depth of the keyway and also the surface that gages the minimum depth, or 1.268 "Go" depth. By this method of making the gage, the radius to which the surfaces are ground will be slightly greater than the radius of the hole in the part gaged. The difference is so slight, however, that it is of little account.

In cases where a slight irregularity of the straightness of the keyway would be permissible, the gage shown at *A*, Fig. 4, can be used, thus permitting a little more tolerance. In using this gage, the maximum width size of the gage, which is usually the "No Go" size, is permitted to enter the keyway in the part being gaged, but the work is rejected if it enters up to the shoulder of the gage. When the conditions are such that a keyway in a part that is to be clamped to a shaft serves as an auxiliary or precautionary means of preventing slippage, as in the case of the part shown in Fig. 2, the type of gage just referred to cannot, of course, be used. For work of this kind, a gage such as shown at *B*, Fig. 4, is used. This gage is designed to permit the "No Go" width end to enter the keyway up to the shoulder.

Gaging Keyway in Tapered Hole

The general practice of broaching a keyway in a tapered hole, as indicated in Fig. 5, insures having the keyway properly located radially in relation to the center of the hole. This method of machining permits the use of a simple gage, of the type shown in Fig. 6, for gaging the depth of the keyway. This type of gage is very satisfactory and inexpensive.

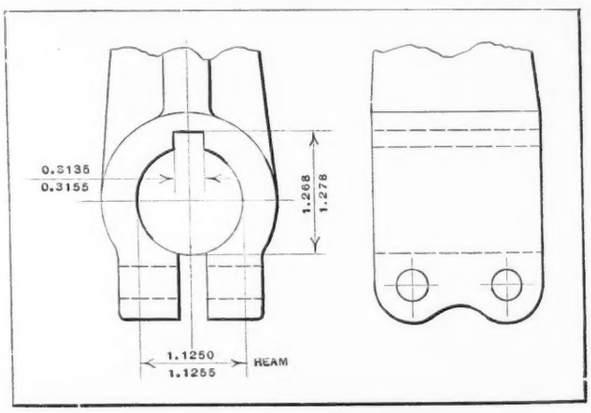


Fig. 2. Split Part with Accurately Dimensioned Keyway Checked by Gage B, Fig. 4

The width is gaged by "Go" and "No Go" sides, and the depth by the minimum and maximum steps *A* and *B*, when the "Go" side of the gage is in the keyway, as indicated. When the keyway is machined to the minimum depth, the step *A* will be flush with the face of the hole, and when machined to the maximum depth, the step *B* will be in the flush position. As the taper is 1.000 inch per foot, the difference between the depth gaged by steps *A* and *B* is equivalent to the diametral tolerance of 0.010 inch on the depth of the keyway.

When the face at the small end of the tapered hole is machined instead of the face at the large end, or the dimensions for the depth of the keyway are given at the small end, the gage may be made

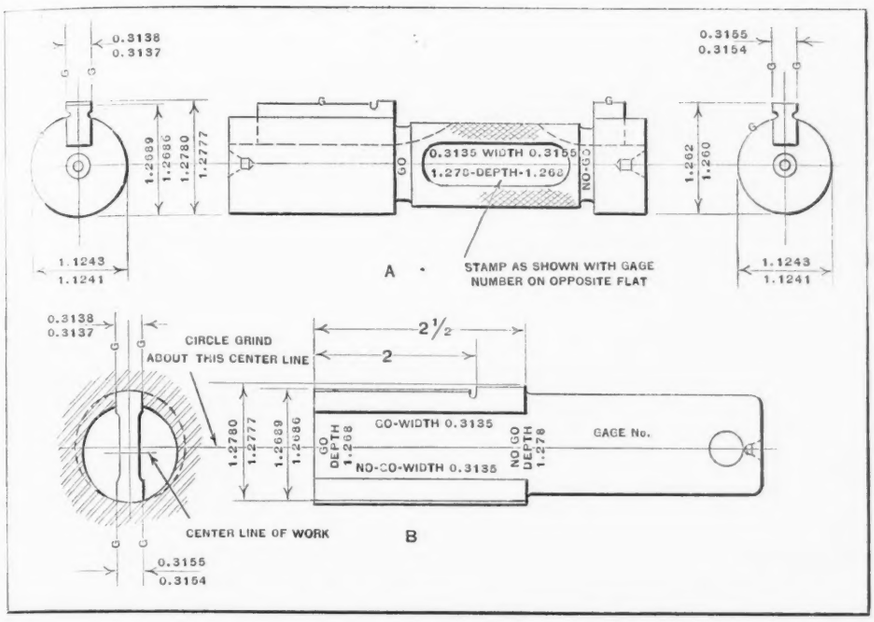


Fig. 3. Gages for Width and Depth of Keyways in Cylindrical Holes

with steps at the smaller end, as shown in Fig. 7. The construction of gages of this kind is simplified by circle grinding about the center line of the gage, located half way between the center of the hole and a point representing the minimum depth of the keyway. By this method of grinding the gage, the radius to which the contact surface is formed is greater than the radius of the hole in the part. However, the difference is so slight that it is of little account.

Gaging Keyseats in Shafts

The width and depth of a straight keyseat in a shaft, such as shown in Fig. 8, may be gaged with a combination "Go" and "No Go" width and "Go" and "No Go" depth gage, such as shown in Fig. 11. In Fig. 10, however, is shown a practical and economical gage. The latter type of gage is so designed that the depth of the keyseat is gaged by the edge of the hole on the "Go" end. When one end of the gage becomes worn excessively, the end can be indexed or its position changed in the holder to bring another side into the gaging position. Therefore, the gage ends need not be replaced until all four sides have been worn out.

Woodruff keyseats, such as shown in Figs. 12 and 14, are commonly gaged with the type of gage shown in Fig. 13. However, in Fig. 15 is shown a gage which is equally satisfactory. This gage is of the same general type as the one shown in Fig. 10. The depth is gaged by the edge of the hole in the "Go" end of the gage, and when the end has worn down to the allowable limit, it can be rotated into a new position in the holder and clamped in place. The actual sizes to which the "Go" and "No Go" members are made are calculated from standardized gage tolerance data. The sizes thus computed take into account the combined gage allowances for wear and the gage-makers' tolerances.

Dimensioning Keyways and Keyseats

At this point it may be well to refer to the various illustrations and carefully note the method of dimensioning. Keyways and keyseats, as illustrated in Figs. 1 and 8, are dimensioned according to the most common method, which is a practical one.

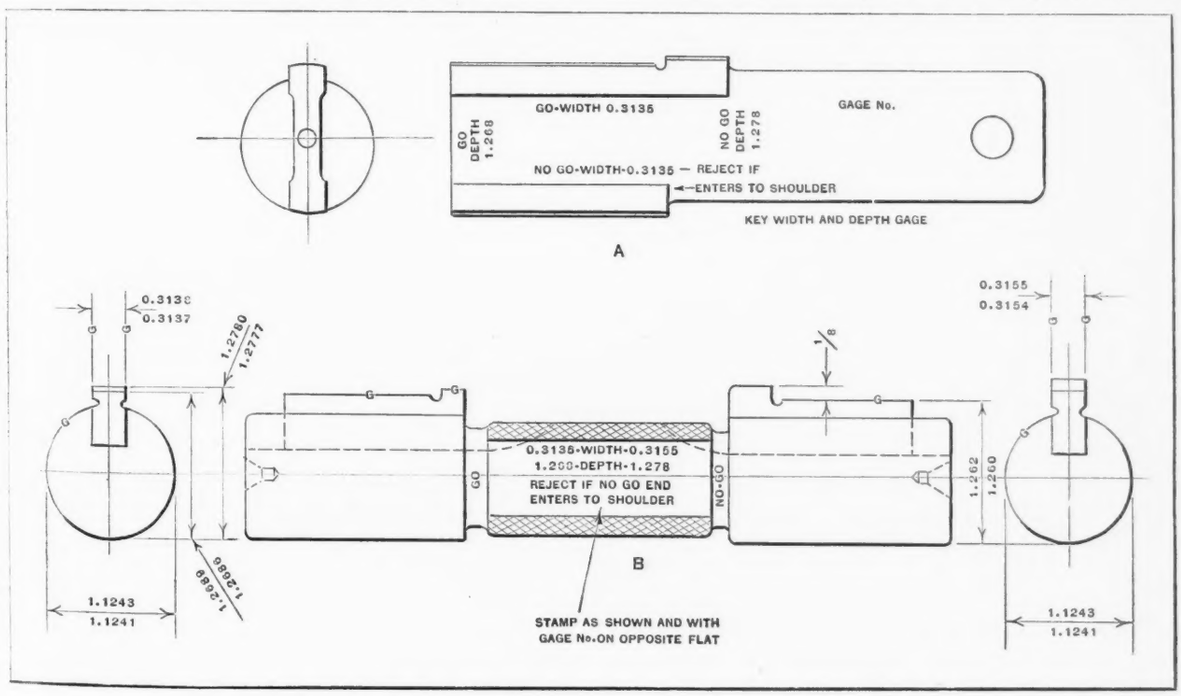
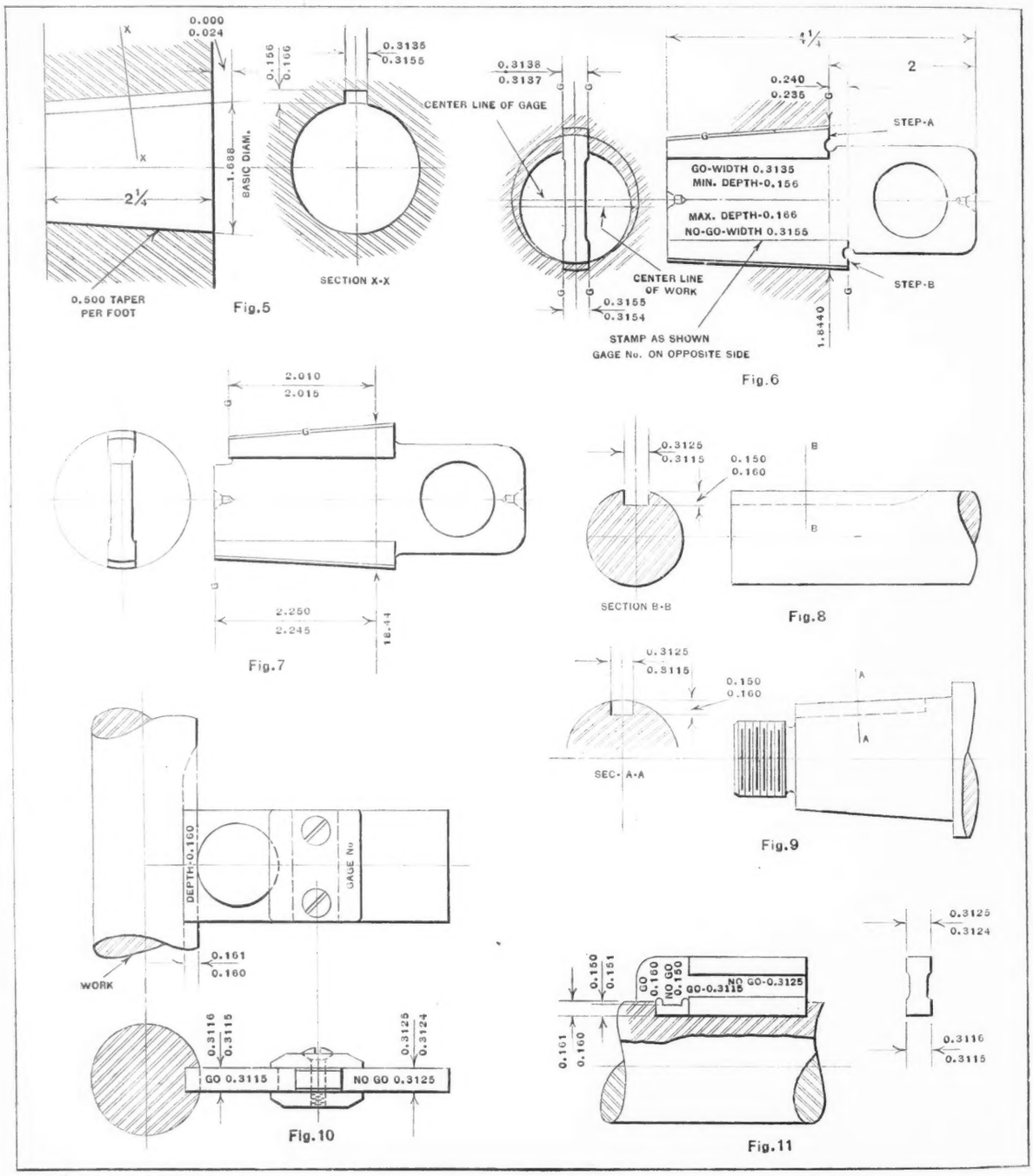


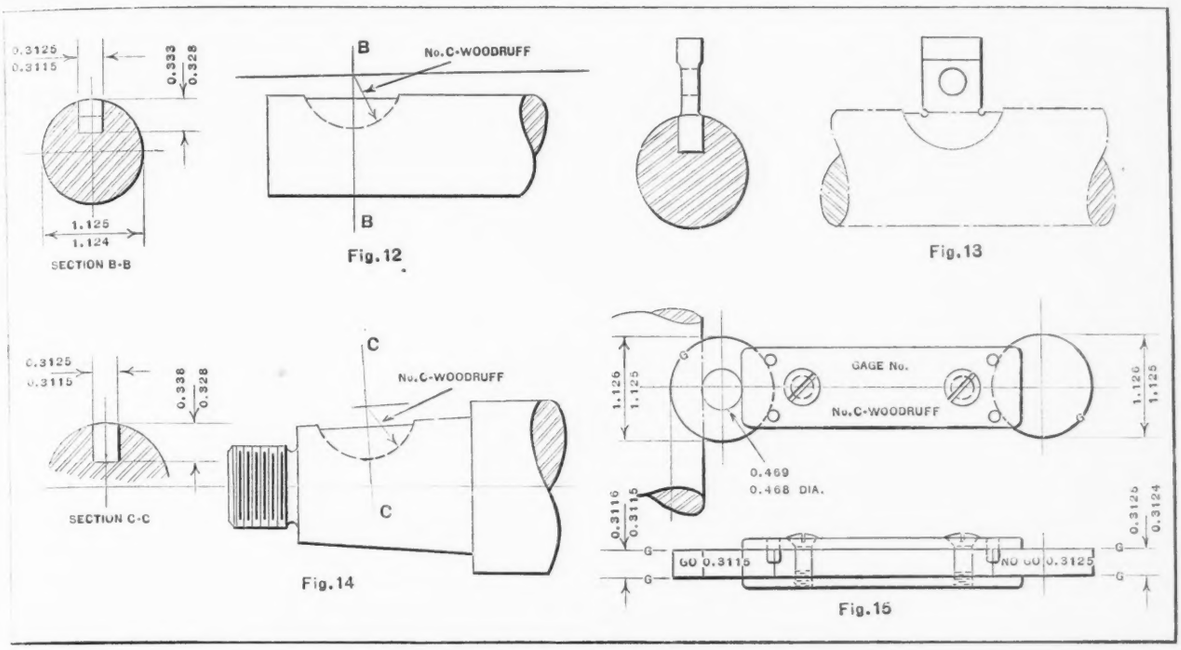
Fig. 4. Additional Types of Keyway Width and Depth Gages

However, this method of dimensioning when applied to keyways and keyseats in tapered parts, such as shown in Figs. 5 and 9, may cause considerable confusion, because the depth of the keyseat, as dimensioned by this method, is different at every point on the taper and does not express clearly the depth of keyway desired. The key used in connection with the assembly of two tapered parts, such as shown in Figs. 5 and 9, is usually fitted into a keyseat and keyway so that the top and bottom surfaces are parallel with the taper. With these points in mind, the depth of the keyseats and keyways are indicated on the sections at right angles with the tapered surfaces.

The gaging of splines such as shown in Figs. 16 and 17 is an important operation. Splines of this type are made with 2, 4, 6, 8 and 10 keys or keyways cut integral with the shaft or the part to be assembled on the shaft. The greatest care must be taken to insure having all the keys and keyways machined to their correct sizes, and in their correct radial positions with respect to the shaft or hole, and to each other. To insure accuracy in this respect, the following method of gaging is employed. Each key or keyway is gaged individually for size and depth with a limit snap gage in the case of a shaft, and with a limit "Go" and "No Go" gage (see Fig. 18) in the case of keyways in parts which are to fit splined shafts. The diameters are also gaged individually with a limit "Go" and "No Go" plug gage for the hole. The root diameter of the shaft is gaged by a special snap gage.



Figs. 5 to 11. Gages for Keyways and Keyseats in Straight and Tapered Parts



Figs. 12 to 15. Keyseat Gages for Woodruff Keys

Use of Functional Spline Gages

When assured that the width of the keys and keyways, and the diameters are within their tolerance specifications, the radial location of each key and keyway is gaged with a functional spline ring gage such as shown in Fig. 19. These gages are designed to permit the greatest allowable tolerance on the radial location and the relative positions of the keys or keyways consistent with proper assembling of the parts. The size of the functional spline plug gage is carefully calculated to provide a clearance between the gage and the minimum size of the spline hole in the part. This clearance is made equal to 40 per cent of the minimum clearance that is allowed between the parts to be assembled.

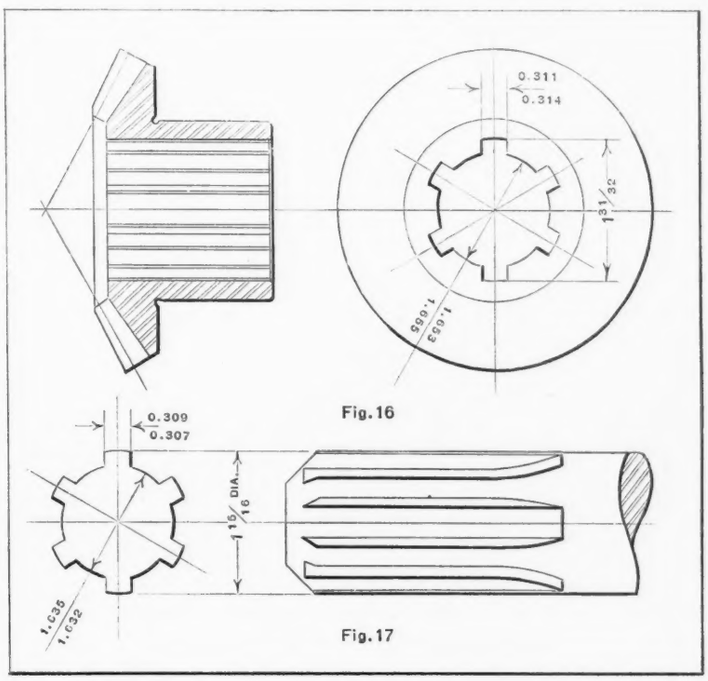
The size of the functional spline ring gage is also carefully calculated to provide clearance between the gage and the maximum size of the splined shaft equal to 40 per cent of the minimum clearance that is allowed on the parts to be assembled. It will be noted from the illustrations that the functional gages are of the "Go" type. If the keys and keyways in the parts being gaged are correct with respect to their radial and relative positions, the gage will entirely enter the part. The gages are designed so that only two keys or keyways on the gage enter the work at one time. This enables the inspector to locate any key or keyway on the part which is not in its correct radial or relative position. Spline plug gages like the one shown in Fig. 19 are usually machined from a solid bar of good grade gage steel, and the gaging surfaces are hardened, seasoned and accurately ground. The following data has been compiled for use in determining the sizes of functional spline plug gages such as shown in Fig. 19:

A = Minimum outside diameter of the spline hole minus 40 per cent of minimum outside diameter clearance. (Minimum outside diameter clearance equals minimum outside diameter of spline hole minus maximum outside diameter of shaft.)

B = Minimum hole diameter minus 40 per cent of minimum root diameter clearance. (Minimum root diameter clearance equals minimum hole diameter minus maximum root diameter of shaft.)

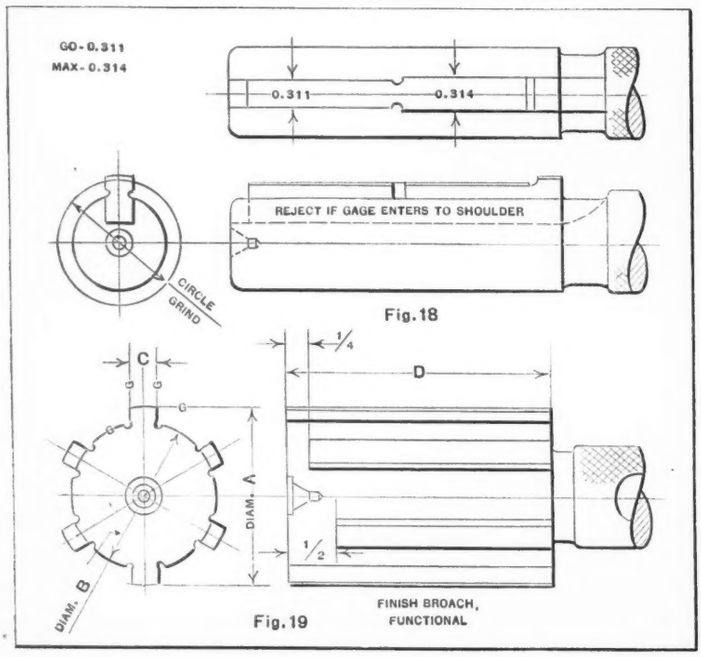
C = Minimum width of keyway minus 40 per cent of minimum width of key and keyway clearance. (The minimum key and keyway clearance equals minimum keyway width minus maximum key width.)

D = Length of spline hole plus 1/2 inch.



Figs. 16 and 17. Splined Gear and Shaft

In Fig. 20 is shown



Figs. 18 and 19. Gages for Width and Depth of Splines

the functional spline ring gage. Gages of this type are of solid construction and are generally made from cylindrical pieces of gage steel. The gaging surfaces can be easily and accurately ground to size. The data for designing functional spline ring gages is as follows:

G = Maximum outside diameter of shaft plus 40 per cent of minimum outside diameter clearance. (The minimum outside diameter clearance equals the minimum outside diameter of the spline hole minus the maximum outside diameter of the shaft.)

H = Maximum root diameter of shaft plus 40 per cent of minimum root diameter clearance. (Minimum root diameter clearance equals minimum hole diameter minus maximum root diameter of shaft.)

J = Maximum key width plus 40 per cent of minimum key and keyway clearance. (The minimum key and keyway clearance equals the minimum keyway width minus the maximum key width.)

Checking Spline Gages

In Figs. 21 and 22 are shown the methods of expressing the gage tolerance permitted on the radial location of the keys and keyways with relation to each other. This method consists of showing the rolls in place on the gage drawing as indicated. The accuracy depends upon the class of spline fit required for the proper assembly of the parts. On spline gages for parts such as sliding transmission gears, the following expressions are used: Measurement over the rolls between any two keys must be equal within plus or minus 0.0003 inch. Accurate measurements of the spline plug gage may be obtained quite readily.

There are several methods of holding rolls in place to obtain accurate measurements of the spline ring gage, but the one illustrated is simple and economical. This method necessitates the employment of two accurate parallels especially made for checking spline ring gages. The parallels are held in place in the slots with accurate gage-blocks so that the rolls may be employed as shown in the illustration. The width of each slot can readily be measured with gage-blocks, and the bore diameter with an internal micrometer. If the gages are correct, the plug gage will fit the ring gage.

* * *

OFFICERS OF MACHINE TOOL BUILDERS' ASSOCIATION

At the meeting of the National Machine Tool Builders' Association held late in October, the following officers were elected to serve during the coming year: President, Henry Buker, vice-president of the Brown & Sharpe Mfg. Co., Providence, R. I.; first vice-president, H. E. D. Gray, secretary and treasurer of the Landis Tool Co., Waynesboro, Pa.; second vice-president, Charles C. Swift, manager of the Ohio Machine Tool Co., Kenton, Ohio; treasurer, August H. Tuechter, president of the Cincinnati Bickford Tool Co., Cincinnati, Ohio.

The following new directors were also elected: E. J. Fullam, secretary and treasurer of the Fellows Gear Shaper Co., Springfield, Vt.; C. A. Johnson, president of the Gisholt Machine Co., Madison, Wis.; and Frederick V. Geier, vice-president and secretary of the Cincinnati Milling Machine Co., Cincinnati, Ohio.

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The total investment in the railroads of the United States at the end of 1927 amounted to $24,870,000,000.

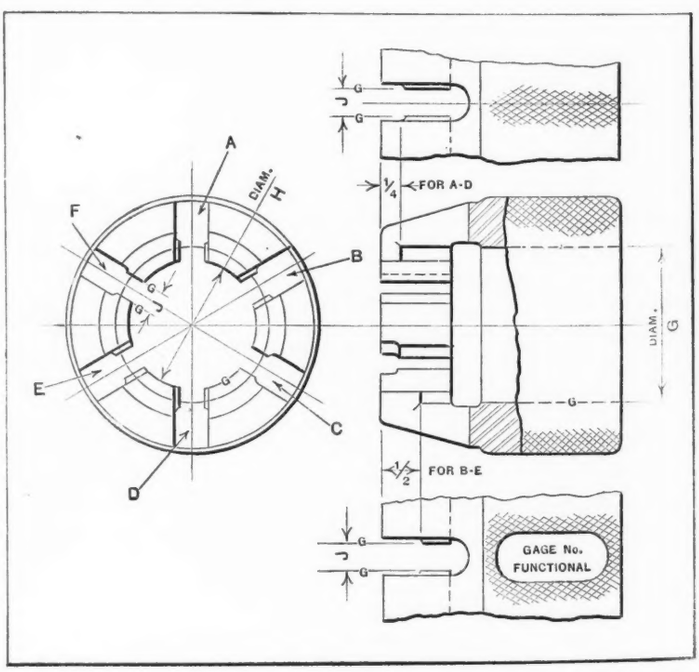
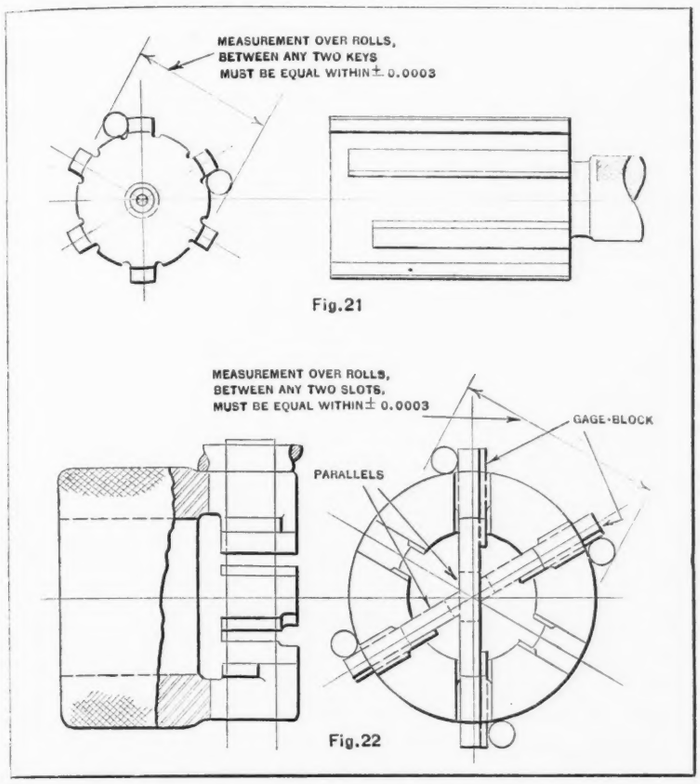


Fig. 20. Functional Ring Spline Gage



Figs. 21 and 22. Methods of Expressing Tolerances on Drawings of Splined Parts

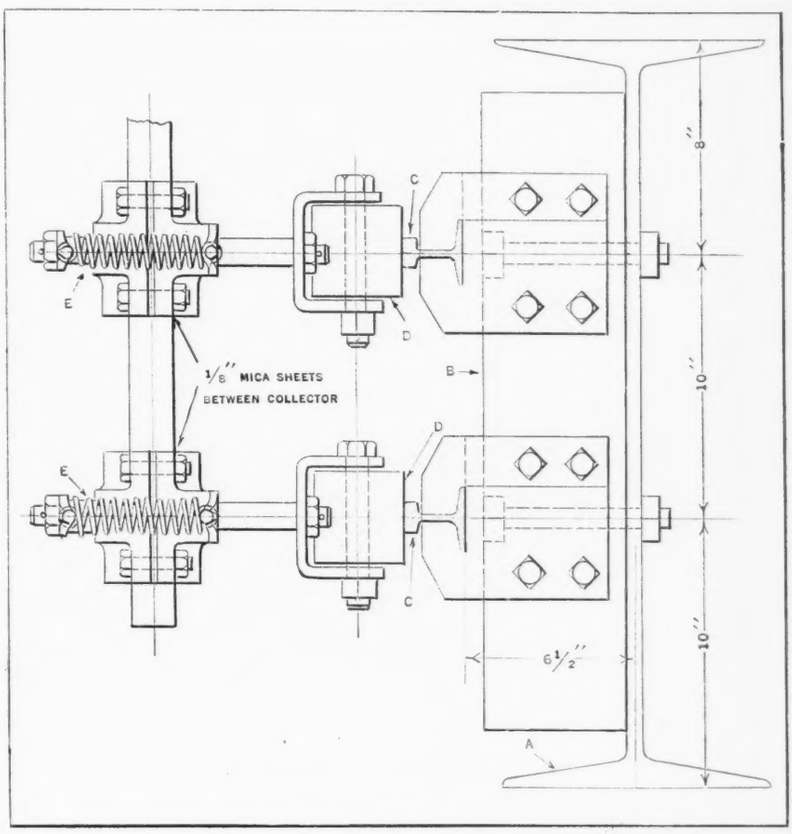
POWER COLLECTOR ROLLERS FOR CRANES

By N. D. YANT

In our shops we had considerable trouble, at times, from the bare copper wires used to carry current for overhead traveling cranes. These wires had to be carried along the sides of the girders that formed the crane runways, and occasionally they got knocked off the brackets, with the result that the wires would strike the steel work or other wires, and throw out the circuit breaker in the power house or burn the wires in two. Finally it was decided to use tee-rails in place of copper wires, and then came the idea of collectors that would always make a good contact with these rails. The arrangement shown in the accompanying illustration has given good results for two years. In that time, not a single mishap has occurred. The collector rollers wear out in time, of course, as may be expected, especially when considering the lengths of our runways, but the rollers are readily replaced.

In the illustration, *A* is the crane girder, and *B* is one of the blocks of wood which are bolted to the girder at regular intervals. To these wooden blocks, in turn, are bolted pairs of metal plates suitably shaped to grip the power conducting rails *C*.

The collector rollers *D* are held in brackets at the ends of rods, which are supported in holders bolted to a rod dropped from the crane end cradle. The springs *E* insure uninterrupted contact of the collector rollers on the rails.



Arrangement of Current-carrying Rails and Collector Rollers for Cranes

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SHIPPING ON SKID PLATFORMS

At the annual meeting of the American Society of Mechanical Engineers, a session on Thursday, December 6, at 2 P. M., will be devoted to a discussion of the shipment of materials on skid platforms. The Department of Commerce is aiding in a movement to standardize mechanical equipment for the handling of materials and to provide interchangeability of its use. A paper by R. L. Lockwood, of the Department of Commerce, will deal with the development of methods of shipping material on skid platforms, and explain the importance of the interchangeability of this equipment. Railway and navigation company officials will also present papers, and the part played by the manufacturer of trucks and skids in the adoption of interchangeable equipment will be presented by F. J. Sheperd, Jr., treasurer of the Lewis-Sheperd Co. C. B. Crockett of the industrial truck department of the Society for Electrical Development, will speak on "Economic Aspects of Skid Shipment from the Standpoint of the User."

INDEXING TURRET LATHE CHUCK

In a turret lathe operation performed on oil-pump bodies in the Racine, Wis., plant of the Nash Motors Co., use is made of an indexing chuck, which permits the complete machining of two chambers in one operation. Fig. 1 shows the details of the oil-pump body, while Fig. 2 illustrates the turret lathe equipment. The chuck is of such a design that either center *X* or center *Y* of the pump body can be made to coincide with the center line of the machine spindle. Hole *A* is supported on a center within the chuck, the housing around

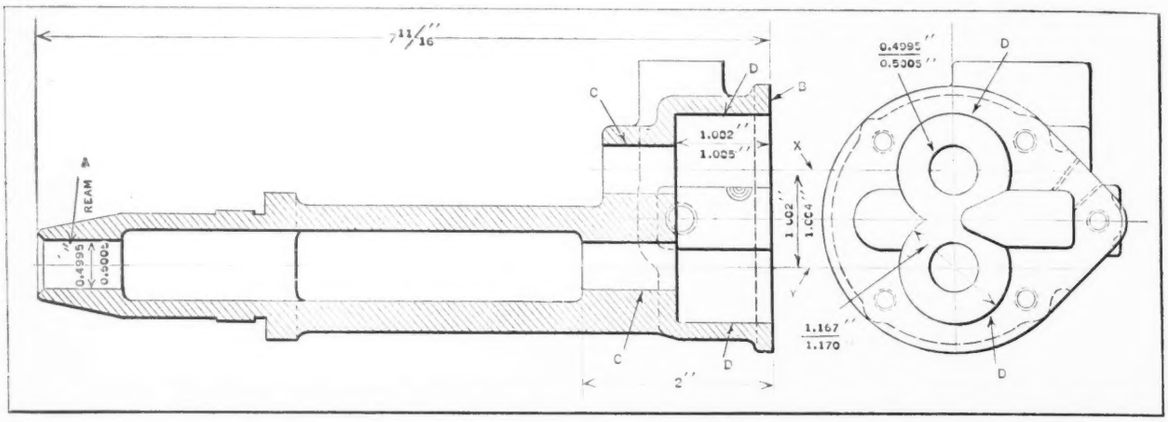

Fig. 1. Oil-pump Body Having Two Chambers which are Machined in One Turret Lathe Operation

the two pump chambers being held in V-blocks, *P* and *Q*, Fig. 2. Both of these V-blocks are adjustable, but only block *Q* is opened and closed for reloading. This is accomplished by applying a wrench to a screw-head.

In the first half of the turret lathe operation, either center *X* or *Y* may be in line with the spindle center. The first step consists of facing surface *B* with a tool on the cross-slide. Then a drill on the turret is employed to start hole *C*. A drill on the second face of the turret completes the drilling of this hole, after which a tool on the third turret face bores hole *D*. When the turret has been indexed to the fourth position, hole *C* is reamed. A tool on the fifth turret face rough-counterbores chamber *D*, and this chamber is finally finish-counterbored by a tool on the sixth turret face.

When the first half of the operation has been completed, a spring plunger in the chuck housing, which engages either of two bushings in an eccentric sleeve on which V-blocks *P* and *Q* are mounted, is raised from the bushing. The sleeve is then indexed 180 degrees, at which point the plunger is entered into the second bushing. Assuming that center *X* of the work, Fig. 1, has previously been in line with the spindle center, center *Y* will now be in line with it. If center *Y* were in line with the spindle center for the first step, the reverse would, of course, be true. The second pump chamber is then machined in the same manner as the first. By completely machining the two chambers in one set-up of the work, a production of fifteen pieces per hour is obtained. These pump bodies are iron castings. One of them is shown at *T*, Fig. 2.

From Fig. 2 it will be seen that the work is well supported for the operation, only the face of the pump body being visible. The extended end of the chuck housing is supported by a steadyrest *U*, mounted on ways on the machine bed. This steadyrest is equipped with three radial ball bearings, as at *R* and *S*, which come in contact with a steel ring on the chuck housing as the machine spindle and housing rotate together. Each ball bearing is mounted on a stub eccentric shaft, and as play develops between the ring and the bearings, these eccentric shafts can be turned slightly to eliminate the play.

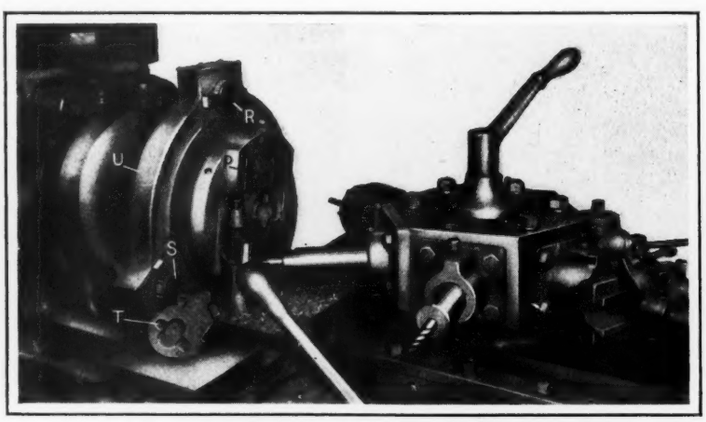

Fig. 2. Turret Lathe Equipment Used in Finishing Two Chambers of a Pump Body by Employing an Indexing Chuck

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WIDE USE OF OXY-ACETYLENE PROCESSES

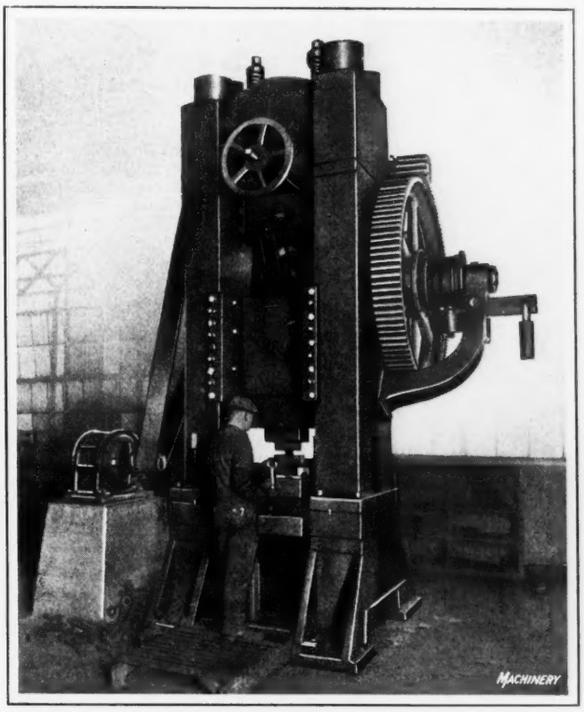
One of the outstanding features of the convention of the International Acetylene Association, held at the Congress Hotel, Chicago, Ill., November 14 to 16, was a report by the Oxy-acetylene Committee of the association, which is the most complete and comprehensive survey of the uses of oxy-acetylene welding and cutting that has ever been attempted. The report contains about 40,000 words. It reviews the almost endless variety of articles that are fabricated by means of the oxy-acetylene welding process, and gives details of the use of this welding process in a number of the most important metal-working industries in the country. The headquarters of the International Acetylene Association are at 30 E. 42nd St., New York City.

Notes and Comment on Engineering Topics

The fact that 40,000 glass eyes are imported annually into the United States should serve as a warning that some carelessness still exists.

In the last sixteen years the number of freight cars of the railroads of the United States has increased only 10 per cent, but the average carrying capacity per car has increased 23 per cent, so that the total carrying capacity of the freight cars now in use is 35 per cent greater than in 1911.

It is claimed that in applications requiring the operation of gears in an atmosphere laden with dust particles, such as are found in cement mills, foundries, coal mines, and similar places, non-metallic gears have an advantage over metal gears. This claim is based on the property that non-metallic material has of reducing the grinding action that develops when these particles fall upon the revolving gear teeth. In the case of metal teeth meshing with metal teeth, the cement, sand, coal, or coke dust acts as a rapid abrasive against the hard surfaces of the gears. This condition is greatly relieved by the non-metallic material, as it offers a surface that is less hard and more flexible, thereby decreasing the high abrasive action.



Coining Press Used in Making Packard Connecting-rods, Replacing a Former Machining Operation and a Straightening Operation and Saving the Time of Three Men

The British Industries Fair will be held in the Exhibition Buildings, Castle Bromwich, Birmingham, from February 18 to March 1, 1929. The Canadian Government will be prominent among the new exhibitors at the 1929 Fair.

It was recently announced by the Soviet Government that tungsten ore deposits of the Transbaikal region of Siberia have been placed on the list of resources open to exploitation by foreign firms. Preliminary explorations of the field indicate the presence of large reserves, which have been worked to a very slight extent for a number of years, and are as yet almost undeveloped. The Soviet domestic market would have the priority rights of purchasing the output, the surplus production going for export.

It has been estimated that nearly 10 per cent of the nation's annual lumber output is used in the manufacture of containers that are generally discarded after they have served in shipping commodities.

It is generally assumed that the sailing vessel has been crowded off the seas. There are still, however, 350 vessels, aggregating 280,000 tons, engaged in the foreign trade of the United States.

While Canada has not sent airplanes to the North Pole or across the Atlantic, the Dominion has obtained leadership in at least one branch of flying—that of aerial surveying and air-mapping. In a period of five years, more than 200,000 square miles of hitherto inaccessible country, richly endowed with natural resources, have been photographed and mapped. Approximately 172,000 photographs have been taken during the last five years, to form the basis for mapping the country, and 50,000 of these photographs were added last year. In this work, airplanes have flown a distance equivalent to eight flights all the way around the world. Fire protection of 200,000,000 acres of forest land is also effectively accomplished by means of airplane scouting and observation.

A novel development in motor-bus transportation has been inaugurated in England. A sleeping bus is now operating between London and Liverpool. This bus is about 27 feet long, and has three compartments, each containing four berths, with a porter in attendance. The bus compartments are provided with hot and cold water, electric lights, bells, and lavatory. A kitchen is also provided for serving a light breakfast. The buses, it is stated, leave London at 11 P.M., arriving in Liverpool the following morning at 8 o'clock.

According to estimates made by the American Motorists' Association, the automobiles in the United States consume daily about 32,500,000 gallons of gasoline.

Current Editorial Comment

In the Machine-building and Kindred Industries

A MACHINE BUILDERS' ASSOCIATION

In Germany the entire machine-building field is united in a single association which, in turn, has branch associations that include the manufacturers in different branches such as machine tool builders, hydraulic machinery manufacturers, builders of cranes and hoisting equipment and other divisions of the industry. This association has proved of great value to the German industries, especially during the difficult years since the war.

In the United States we have no general association of this kind. Among the entire machinery building industries there are less than a dozen associations, of which the National Machine Tool Builders' Association is the largest and most active. According to the figures of the Department of Commerce, there are approximately 10,000 manufacturers of machinery of all kinds in the United States. Of these less than 1000 are members of some trade association, the industry as a whole being unorganized.

Many of the problems of machinery manufacturers are common to all. The materials, equipment, and methods are similar in all machine-building shops; and so are the problems of training apprentices and workers and of handling labor. The marketing problem, trade abuses, price-cutting and excessive demands for service are problems that practically every branch of the industry must face. Leaders in the machinery industry are beginning to recognize this fact and efforts are now being made to form an association comprising our entire machinery industry, providing that the different branches shall function independently through their own trade organizations. It has been said truly that "the machinery industry maintains the standard of living," and so important an industry would be greatly helped in the solution of its problems by a suitable organization.

* * *

WELDED JIGS AND FIXTURES

A new development in the construction of machine shop equipment and accessories was pointed out by J. R. Weaver, superintendent of manufacturing equipment, Westinghouse Electric & Mfg. Co., at the Machine Shop Practice meeting recently held in Cincinnati. Some of the large electrical manufacturers are employing electric welding quite extensively in the making of jigs and fixtures. This reduces the machining time considerably and thus decreases the cost of the tool equipment. At the Westinghouse plant, it has been possible also to gain, on an average, three weeks on the delivery of each jig and fixture, because the time required for making a pattern and a casting is saved when the body of the tool is built up from welded structural steel shapes.

Mr. Weaver's suggestion opens up a large additional field for electric welding. In some cases, castings are preferred to welded construction for machine frames, because of the appearance produced by the former method; but even in that respect great advances have been made by many companies using electric welding, as shown by the attractive appearance of electrical and other machine frames made by them. With jigs and fixtures which are not made for sale, but simply for use within the shop, the factor of appearance is less important, and simple, easily welded designs can be produced with great savings in time and cost.

* * *

PAY ATTENTION TO LUBRICATION

Many of the problems of the shop—motor drive, safety appliances, convenient arrangement of machinery, and even the trucking of parts from department to department—are considered more important than the question of lubrication and are given more consideration in most shops; yet most breakdowns of machinery are due to bearing troubles, and many bearing troubles result from faulty lubrication. The cost of stoppage of production due to machinery breakdowns runs into large figures.

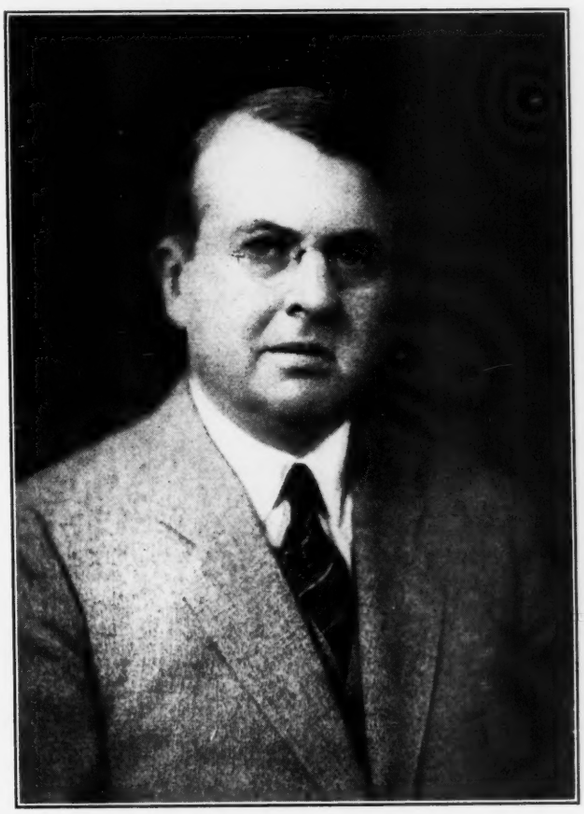
Some of the larger corporations are beginning to recognize the importance of lubrication, and are now employing men known as lubrication engineers, whose sole duty it is to study the best means of lubrication for different types of equipment. A number of manufacturers of lubricating equipment are also prepared to render this service to smaller plants that cannot afford to employ a lubrication engineer. Much money is wasted and poor operating results are obtained through paying good money for good lubricants and applying them in a haphazard manner by means of unsuitable devices. A good lubricating device is almost as important as a good lubricant, and different conditions require different types of oil or grease cups. These conditions should be investigated and a proper device adopted.

An example of savings possible through proper lubricating means will prove of interest. In one plant a very large press had to be stopped for half an hour each time fifty-six oil-cups on the machine were filled. The machine operated continuously day and night and had to be lubricated twice each twenty-four hours, which meant a loss of one hour in each twenty-four. The production value of the press was estimated at $30 per hour, which represented the loss in the earning capacity of the press. A modern lubricating system was installed, costing $900, which made it possible to lubricate the machine while running, so that the first cost was saved in some thirty working days.

Enlisting the Interest of Your Employes

By JAMES F. DONAHUE, Vice-president and General Manager, The Foster Bolt & Nut Mfg. Co., Cleveland, Ohio

"GET your employes vitally interested in the problems of your company and then ask them to help you with the solution." This is the advice which I would earnestly give to any executive overburdened with the cares of managing an industrial enterprise. You may fill your shop with the latest types of machines and material-handling equipment, but unless you can obtain true cooperation from your employes, you will be unable to give your customers the utmost in product, quality, and service.



James F. Donahue, Vice-president and General Manager, The Foster Bolt & Nut Mfg. Co.

Standards of quality are being constantly raised to higher planes which must be met if the average metal-working concern intends to stay in business. In many instances during the last few years, manufacturing methods have been revolutionized by the demands of the automotive field alone for parts of higher quality, with lighter weight and lower cost. The cap-screw industry today, for example, manufactures for the automotive field cap-screws having a tensile strength of from 100,000 to 125,000 pounds per square inch, whereas ordinary commercial cap-screws have a tensile strength of approximately 60,000 pounds per square inch. Just as this demand was made on the cap-screw industry, other industries are constantly required to meet similar problems of higher quality. Concerns in any field that cannot meet new standards of quality, will necessarily find themselves passing out of existence.

Let Your Employes Know that the Management Has Confidence in Their Ideas

To meet the constant demands for increased quality and lower costs, metallurgical researches, improved machining methods, new inspection devices, etc., are usually necessary. This means the expenditure of considerable sums of money. The most economical use of such funds is possible if executives permit employes to express themselves freely concerning present and proposed methods and then analyze the various suggestions from an impartial standpoint. Above all, the employes must be made to feel that they enjoy the respect of the management to such an extent that the management will spend money on their recommendations.

In other words, sincerity of purpose must be manifested on the part of the management. This has been the policy of the Foster Bolt & Nut Mfg. Co. and the results have been most gratifying. Our business has more than trebled in the last four or five years, due in a large measure to the cooperation of our employes.

How Foster Employes are Given a Voice in the Management

Our company has attempted to discard as far as possible the relation of "employer and employe" and to make employes feel that they are partners in the enterprise. We have shown them that the more money the company makes, the more it can afford to put into their pay envelopes.

Cooperation of our employes has been obtained at both the Cleveland and Chicago plants through the functioning of three committees, each of which is made up of the general manager, the general superintendent, and twelve foremen and higher skilled workmen. These committees are called "Quality," "Service" and "Sanitation." All three meet regularly once a month and more frequently as occasions require.

Since the morale of the employes depends primarily upon the sanitary conditions of the plant, the duties of the sanitation committee will be discussed first. This committee strives to promote cleanliness throughout the shop, and makes a monthly detailed report concerning each department. A spirit of emulation is fostered by hanging signs in the various departments according to conditions existing at the time of each inspection. This committee makes recommendations concerning the cleaning of windows, painting of departments, improvement of lighting systems, etc.

One noteworthy recommendation of the sanitation committee resulted in the erection of a new building at the Cleveland plant to serve both as a

restaurant and as a store-room for miscellaneous parts. Previously, the company operated a restaurant which was unsatisfactory because of inadequate facilities. As a result, the men ate all over the shop, with the consequent scattering of food and rubbish which, of course, attracted vermin. Also, due to the lack of a definite storage department, tools and various appliances were scattered about the floors of the shop. The sanitation committee recommended a new building to eliminate unsanitary conditions and untidy shop appearance. The erection of this structure proved to the sanitation committee and all employes that the concern is earnestly attempting to provide good working conditions.

Increasing Quality and Bettering Service

As its name implies, the aim of the quality committee is to increase the quality of Foster products. Following recommendations of the Cleveland quality committee, the management installed a laboratory in which all steels used are given physical tests and chemical analyses. Another recommendation of this committee resulted in the installation of a modern heat-treating department, including the latest type gas furnaces having thermostatic controls and conveyors for automatically carrying the parts through the heating and quenching operations. More accurate inspection devices advised by the committee have been installed to insure the maintenance of closer working tolerances.

The service committee is composed principally of employes from the packing and shipping departments. The chief duty of this committee is to devise systems of inventory and shipment that will enable the company to give the best possible service to customers. With the present custom of hand-to-mouth buying, large stocks of bolts, nuts, and cap-screws of many sizes must be carried in stock to meet possible orders. However, these stocks must be controlled intelligently, in order to avoid too large a tie-up of financial resources, and the service committee provides this control. It also makes recommendations concerning internal systems of scheduling orders, shipping methods, the use and style of labels and cartons, etc.

Shop Employes are Taught Business Principles

All committee meetings are very informal, and the members are made to feel free to offer any suggestions. Often the meetings are held at my home, and whether there or at the plant, a buffet lunch is always served. At some of these meetings, after reports have been made and action taken on them, executives of the organization explain various business matters of the company so that the shop men may understand some of the manifold problems involved in marketing the products that they manufacture.

Costs and profits are discussed freely. Individual sales problems are taken up, and the men are told just what sales arguments were presented in trying to place the orders and why these orders were finally obtained or lost. Sales talks used by the representatives of competing concerns are also analyzed. The committees are apprised of all conditions surrounding important orders going through the shop, and in this way they come to know the requirements of all major customers.

By teaching the shop men the fundamentals of business, they become more and more interested in the various affairs of the company. As a result, they strive for economical production in their own departments, with increased quality and better service to the customer. In this manner, they become the best salesmen of the company, since they really create the conditions under which the actual salesmen are enabled to place orders.

This cooperation of Foster employes has not, of course, been attained by merely letting them make recommendations leading toward better working conditions and manufacturing methods or by explaining to them business problems and their solutions. It has been secured by engendering a spirit of harmony and good will between the employes and the management through the medium of the committee meetings. Industrial plants earnestly striving to obtain the cooperation of their employes will soon free themselves from labor difficulties.

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CHROMIUM PLATING FOR WEAR RESISTANCE

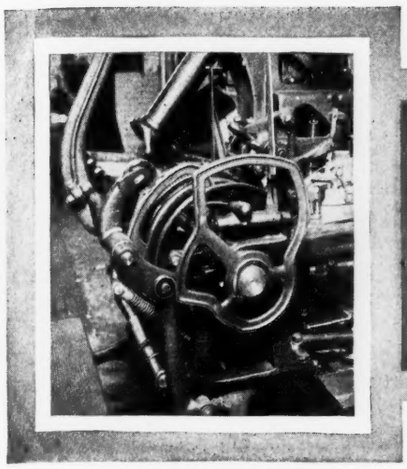
In a paper to be read before the annual meeting of the American Society of Mechanical Engineers, in New York, December 3 to 6, W. Blum, chemist of the Bureau of Standards, Washington, D. C., will deal in great detail with the applications that have been made of chromium plating for purposes in which the wear-resisting qualities, rather than the character of the surface finish, of chromium plate, is of importance.

After giving particulars regarding the physical properties of chromium, such as hardness, thermal expansivity, density, melting point, electrical conductivity, and adherence, the author will discuss the uses to which chromium plating, by reason of its wear-resisting qualities, has been more or less successfully put; namely, its application to gages and other measuring devices; to drawing, forming, stamping, and molding dies; to rolls for forming metals; to tools for cutting metal; to bearing surfaces in machinery, etc. He will show how, in addition to savings due to the longer life of chromium-plated tools and parts, there are savings much greater resulting from reducing the number of times that machines must be stopped for their replacement. This paper will be abstracted in considerable detail in January MACHINERY.

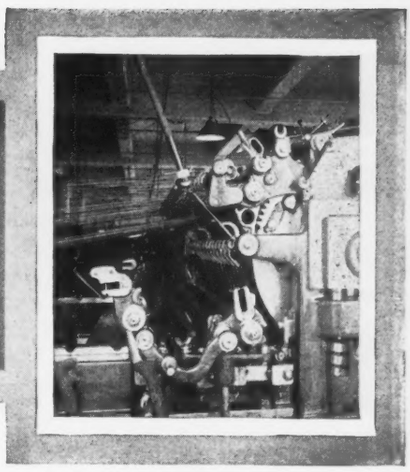
* * *

ANNUAL MEETING OF GRAY IRON INSTITUTE

The newly formed Gray Iron Institute, with offices in the Terminal Tower Bldg., Cleveland, Ohio, held its first annual meeting November 14 in the Cleveland Chamber of Commerce rooms in Cleveland, Ohio. The organization meeting of the Institute was held in Philadelphia May 18 this year, when directors were chosen to serve for a six months' period, and the incorporation of the Institute was authorized. In the intervening period considerable progress has been made. A number of members have been enrolled, and the organization now comprises seventy gray iron foundry companies in various sections of the country.



Ingenious Mechanical Movements



RAPID RECIPROCATING MECHANISM

By S. B. ST. JOHN

An ingenious reciprocating mechanism has been developed for a hat finishing machine to drive a pad having a stroke of 1/2 inch at the rate of 1200 strokes per minute. This reciprocating mechanism has to travel in a quarter circle to follow the hat outline, and the stroke is varied from zero to the maximum automatically, centrifugal force being utilized in conjunction with this variation.

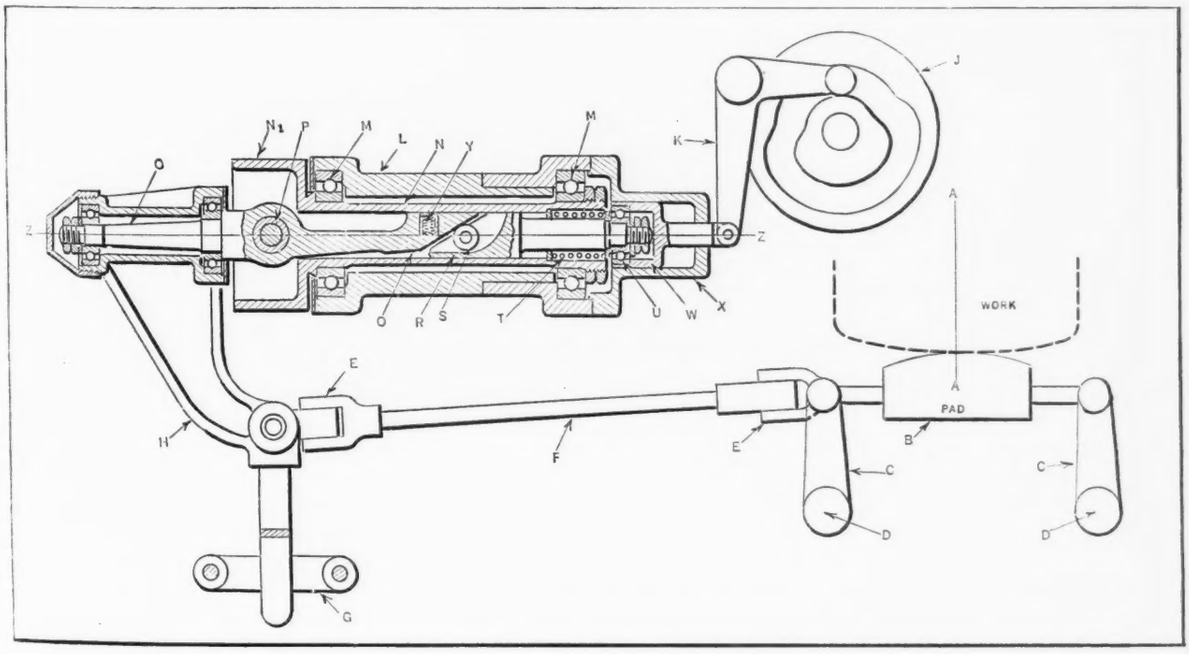
The work, which is held in a chuck, revolves about axis *A–A*. The reciprocating pad *B*, which carries a strip of sandpaper, is mounted on swinging arms *C*, which oscillate about fixed centers *D* and are driven through universal joints *E* and rod *F*. Parts *B*, *C*, and the slotted member *G* have a common support which, with arm *H*, swings about axis *Z–Z*, thus enabling pad *B* to act upon the face and sides of the work.

Casting *L* is part of the main frame and contains ball bearings *M* which support sleeve *N*. Pulley N_1 forms part of this sleeve, and it is driven by a belt from a countershaft. Shaft *O* is mounted on pin *P*, which is supported in the pulley; consequently, shaft *O* revolves with the pulley and it may swing about pin *P*. Arm *H* has a ball-bearing mounting on shaft *O*, as the illustration shows, and an extension of arm *H* fits loosely into slotted member *G*, which prevents *H* from rotating with shaft *O*.

Plunger *R* carries roll *S* and controls the position of shaft *O*. When *O* is in the central position, there is no reciprocating motion, but when the axial movement of plunger *R* allows shaft *O* to swing off center, due to the effect of centrifugal force, a reciprocating motion is obtained. The axial position of plunger *R* is regulated by cam *J*, which transmits motion through bellcrank *K* to housing *W*.

Thus, when housing *W* is moved to the right, spring *T* forces plunger *R* to the right. As this movement occurs, roll *S* releases shaft *O*, which is forced off center by spring *Y*. This spring serves to start the shaft, which is then acted upon by centrifugal force and continues the movement away from the central position until the lower side of the shaft bears against sleeve *N*.

The displacement of shaft *O* causes the axis of the left-hand or outer end to describe a cone about center line *Z–Z*. This motion is changed where the left-hand universal joint *E* is attached, so that a



Rapid Reciprocating Mechanism which is Partly Controlled by Centrifugal Force

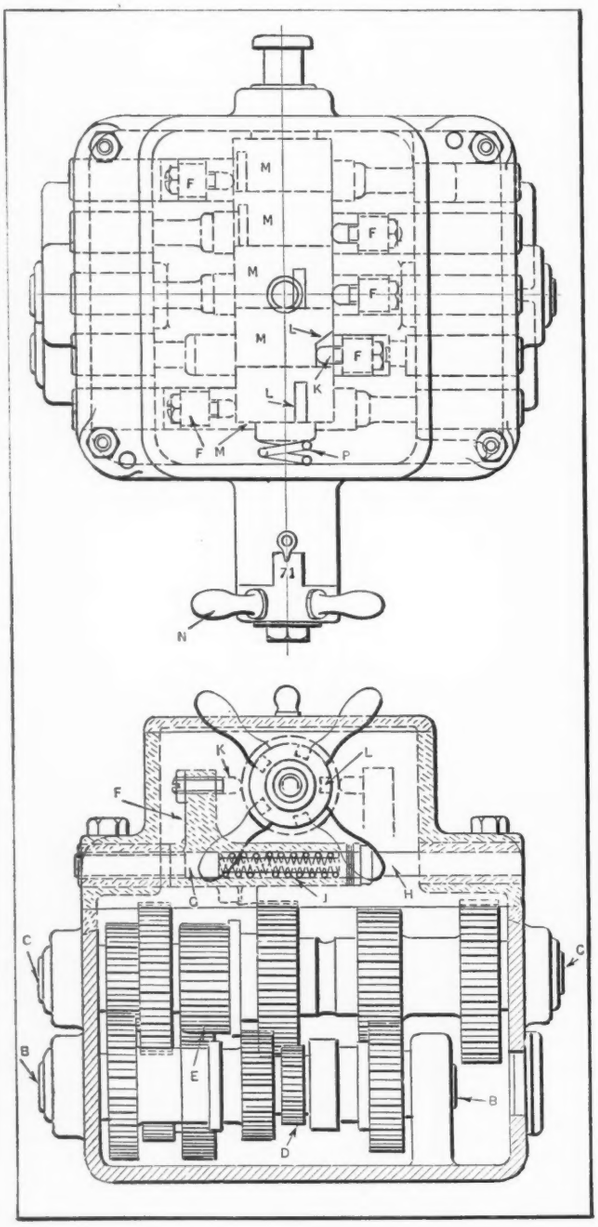
point here generates a flat oval on a spherical surface. The motion is changed again by the swinging supports *C*, so that a point on the pad generates an arc, which is the required motion. In finishing some hats, the pad does not reciprocate, but follows the outline of the hat and "slicks" it. This mechanism, which is covered by patents, has been used for several years on machines employed by leading hat manufacturers, and it has proved very satisfactory for the particular purpose mentioned.

* * *

CHANGE-GEAR CONTROL MECHANISM

By H. C. TOWN

The change-gear mechanism illustrated herewith is designed for machine tools or similar applications, and with it any one of five speeds may be obtained instantly without stopping the machine; or if desired, all gears may be disengaged independently of the driving pulley clutch. There are three equally spaced shafts. The driven shaft is at *C*, the intermediate shaft at *B*, and the driving shaft on which the clutch pulley (not shown) is mounted is located directly back of shaft *B*. The exact arrangement of the gearing will not be described in detail, as the special feature is the mechanism for controlling the gear-shifting.



Semi-automatic Control Mechanism for Speed Changes

There are two gear clutches (as at *D*) on the driving and intermediate shafts. These clutches engage internal involute teeth on adjacent gears which are shifted into engagement. Gear *E* may also be shifted in changing speeds, so that there are five shifting gears. This shifting is effected by five yokes *F* having extensions which reach down to the respective gears. Each yoke is free to slide upon a pin *G*, and the other end is supported by a shaft *H* which is free to slide in the bearing shown. Spring *J* tends to shift the yoke and its gear, but this movement can only occur when stud *K* drops into a slot *L* in its control collar *M*. The plan view shows clearly the five control collars and the yokes, two of which slide to the right, and three to the left. These control collars are mounted on a shaft to which control handle *N* is keyed.

In changing the speed, wheel *N* and all control collars are pulled forward, thus disengaging whatever stud *K* happens to be in a slot. As the plan view shows, the rear ends of the slots are inclined, so that a stud readily rides up on the outer surface. With the wheel *N* in the forward position, the drive is completely disengaged, and as the studs are now riding on the rear surfaces of each collar *M* and beyond the range of the slots, wheel *N* may readily be turned to any one of its five positions; the speed for each position is indicated directly by graduations.

The illustration, for instance, shows the wheel set for a speed of 71 revolutions per minute. When this number is opposite the indicator, wheel *N* is released and spring *P* forces the shaft and control collars back, so that one stud *K* drops into its slot as shown, thus automatically shifting the gearing as required for 71 revolutions per minute.

The clutches have sixteen teeth, so that there are sixteen opportunities for engagement during every revolution of the driving member. Alternate teeth are stepped back slightly to permit easy engagement, so that the "pick-up" is taken on eight tooth faces. This entire mechanism may be disconnected from the driving pulley through an expanding ring friction clutch, which is located in the pulley and operated by a hand-lever and circular rack extending through the hollow driving shaft.

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VARIABLE-SPEED MECHANISM

By C. J. DOLL

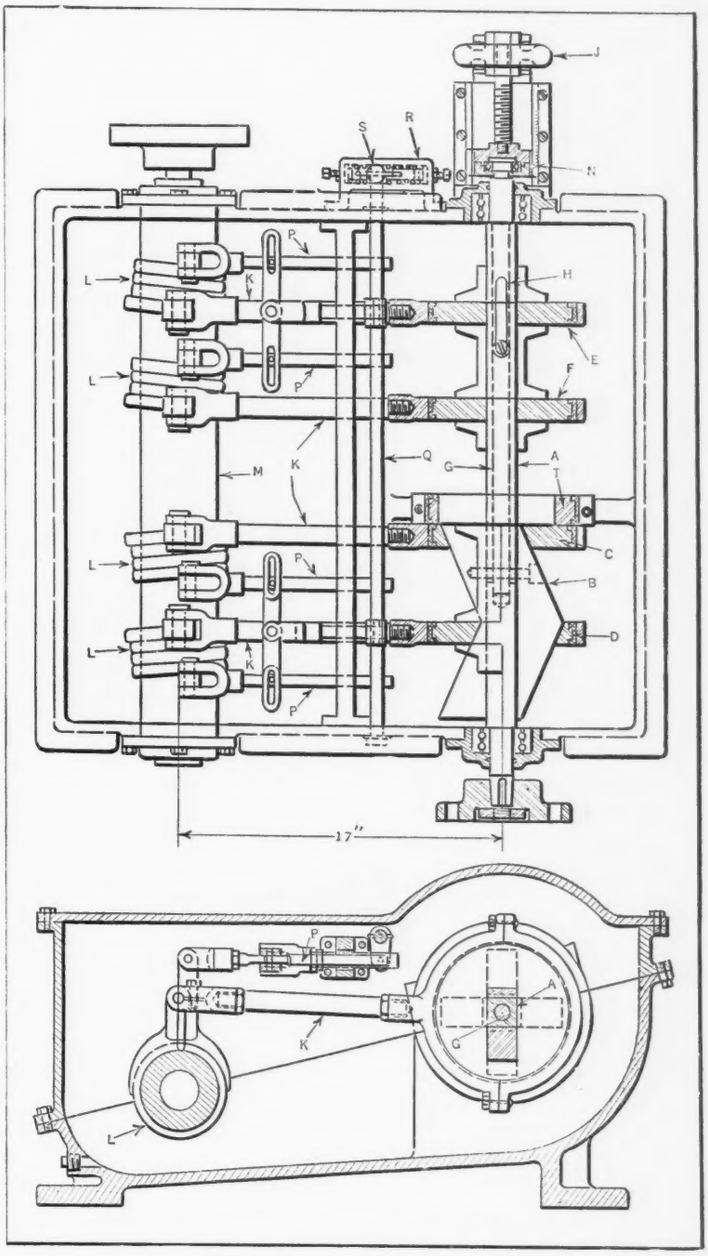
A variable-speed reducing mechanism was required which had to be small and compact, dustproof, free from oil seeping, capable of transmitting from 3 to 10 horsepower, and with a speed range of from 0 to 250 revolutions per minute variable to within one-quarter revolution without stopping the mechanism. The power was to be obtained from a constant-speed motor. After considering these requirements, we decided to build our own speed reducer, as there was no suitable design on

the market. The accompanying sectional and plan views show a mechanism that surpassed the designer's expectation. The efficiency is 95 per cent, and the results exceed the requirements.

The driving motor is connected to a square shaft *A* by a flexible coupling. On this shaft there is a double tapering shoe *B*, which is shifted along the shaft to vary the eccentricity of the cams or eccentrics *C* and *D*. The other pair of eccentrics *E* and *F* also have a similar shoe or wedge, which is located at right angles to shoe *B*, as indicated by the lower sectional view. These tapering shoes are connected by a pull-rod *G* which is attached to the shoes by screws passing through slots, as at *H*. The position of rod *G* and the shoes is controlled by the handwheel *J*, which thus serves to vary the throw of the four eccentrics. These eccentrics, when off center, transmit motion through rods *K* to four coils or grips *L* which, in turn, rotate the driven drum *M*. It will be evident that as the throw of the eccentrics is increased, the speed of drum *M* is also increased, because more motion is imparted to it from the driving shaft.

The speed obtained is indicated by the position of a pointer *N* relative to the graduations, which are subdivided to equal two revolutions of drum *M*. The coils *L* have ears or lugs welded to their ends, and they are ground to an easy sliding fit on the drum. Any motion imparted to rods *K* will give the coils an oscillating motion and cause them to rotate the drum. As these coils have a powerful friction grip, this mechanism readily transmits the required amount of power; in fact, it is capable of transmitting 15 horsepower although only 10 is required.

One end of each coil is attached to a rod *P*, and these rods are connected by levers to shaft *Q* which leads to control box *R* having a control lever *S*. Lever *S* is equipped with a snap cut-out to disengage the tension control members in order to obtain a braking effect from coils *L* in case drum *M* is to be stopped quickly. This driven member may also be disengaged so as to remain stationary while the driving members are running, and the driven part, by means of lever *S*, may also be started at whatever predetermined speed the mechanism is set for. When the motor speed is 1750 revolutions per minute, any speed from 0 to 250 revolutions per minute can be obtained with variations within one quarter revolution, as mentioned. Through this entire speed range, the velocity at the periphery of the coupling on drum *M* is constant. It will be noted that shaft *A* is mounted in standard double-row ball bearings, and also has a stabilizing bearing *T* near the center.



Variable-speed Mechanism Equipped with Adjustable Eccentrics

* * *

It has been estimated that the manganese deposits discovered near Postmasburg, South Africa, contain 500,000,000 tons of that mineral.

NEW TRACTOR PLANT IN RUSSIA

A commission of thirteen Soviet engineers engaged in the construction of the new $17,500,000 Dzherzinsky plant at Stalingrad, has arrived in the United States for the purpose of purchasing equipment and arranging for engineering cooperation on the construction and lay-out of the plant. This tractor plant, on which work was recently begun, is intended to produce 20,000 tractors a year, and will be the largest tractor plant in the Soviet Union. According to information published by the Amtorg Trading Corporation, 165 Broadway, New York City, the Russian Government estimates that a minimum of 220,000 tractors will be required on Russian farms during the next ten years. The Putilovetz Works in Leningrad have in the past produced 1500 tractors a year. These works are being enlarged to have an annual capacity of 5000 tractors. During the current year it is expected that 3000 tractors will be produced at this plant.

Proportional Form-turning Machine

By O. S. MARSHALL

IN Fig. 1 is shown an interesting form-turning machine which is employed in the production of wooden shoe lasts. This machine can be set to turn shoe lasts of the same size and shape as the master or standard model shown at *M* or, by the proper adjustment of the proportional mechanical movement mechanism, it can be made to form lasts that are longer or shorter than the model, as well as thicker or thinner. In addition, the machine can be readily adjusted for turning either left-foot or right-foot shoe lasts from the same model.

The machine or form-turning lathe consists primarily of the framework, two carriages *A* and *B*, the swing frame *C*, the work and the model spindles, and the driving mechanism. The swing frame *C* on which the model and the work are mounted is pivoted overhead at *D* and *E*. The carriage *A* carries the cutter-head *F*, and the carriage *B* carries the model wheel *G*. Wheel *G* rolls in contact with the model *M* during the traverse movement. The in-and-out swinging movements imparted to frame *C* through contact of the model with wheel *G* give the work corresponding movements to and from the revolving cutter. These in-and-out movements result in forming a duplicate of the model or a modification of the model as determined by the setting of the proportional levers previously mentioned.

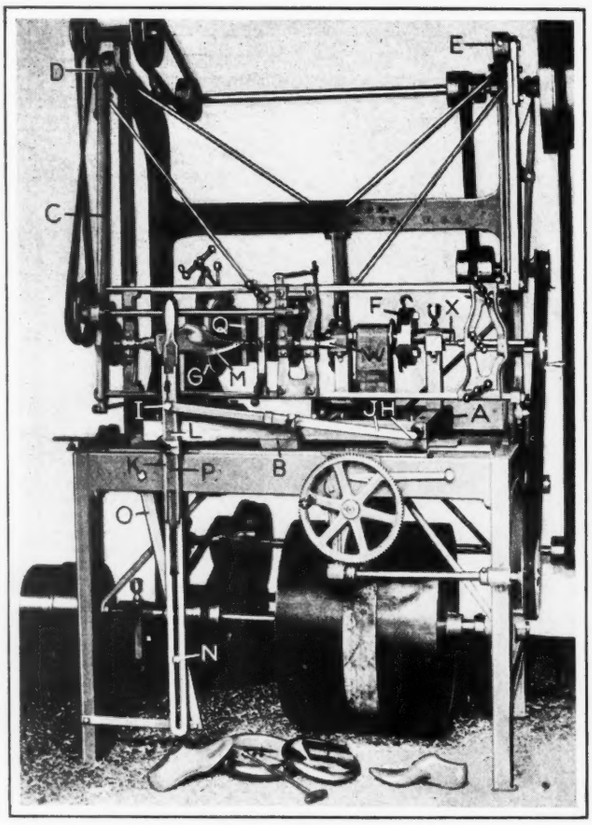


Fig. 1. Form-turning Machine

The horizontal height of the cutter-head is the same as that of the model wheel, but the model wheel may be of smaller or larger diameter than the radius described by the finishing cutter in the head *F*. The line of travel of the carriage is from right to left, and separate ways are provided so that the travel of one carriage may overlap that of the other, as indicated in the illustration. The block to be turned is supported and driven at one end by the two-point live center *W* and at the opposite end by the plain center *X*.

When the machine is in operation, the two carriages are connected at *H* and *I* by lever *J*, which is made in two parts in order to provide for linear adjustment between the carriages. Lever *K* is attached to carriage *B* by a stud at point *L*, and has a fulcrum stud *N*, which is adjustable up or down on the bar *O*. This system of levers, including levers *J* and *K* and bar *O*, with the adjustable bar *P*, takes care of the length variations.

The diagram in the upper left-hand corner of Fig. 2 shows the proper lever settings for producing lasts longer than the model. The left end of lever *J* is set at point *I*, which is the highest position it can occupy on lever *K* above the line *T–T*, along which the carriage travels. The diagram in the upper right-hand corner shows the levers adjusted or connected for turning a last that is shorter than the model. In this case, the point *I*, at which lever *J* is connected to lever *K*, is below the line of travel of the carriages.

The starting positions in both cases are indicated by the full-line views, and the positions at the finishing end of the stroke by dotted lines. A result similar to that obtained with the arrangement shown in the upper left-hand corner of Fig. 2, but somewhat exaggerated, is obtained by employing the arrangement shown in the lower left-hand corner of the illustration. In this case, the position of the fulcrum *N* is changed.

The line of travel of point *I*, as indicated in the latter diagram, is a uniform curve of large radius, while in the case of the diagram shown in the lower right-hand corner, the point *I* follows a symmetrical path which has a depression at the middle point *S* where a slowing up of the movement occurs. The setting shown in this diagram is used for a small-size last, and the change in the rate of movement at the mid point of the stroke does not materially affect the form of the work.

Variations in the diameter of the last are obtained by connecting the swing *C*, Figs. 1 and 3, with an oscillating member *R*, Fig. 3, at the back side of the machine, which provides for a graded horizontal movement of the model wheel in the direction of or away from the model, as required. The two diagrams in Fig. 3 represent end views of

the oscillating mechanism as seen from the right-hand side of the machine.

The model wheel *G* is supported on a movable slide *Q*, which, in turn, carries an adjustable slide having a contact member *U* which bears against the oscillating member *R*. The swinging frame *C* is connected with member *R* by lever *S*. The dotted outline of the model *M* indicates the position it occupies when revolved one-half revolution. With the contact member *U* at the center position on the line of travel *T–T*, there is no variation from the model. The extreme positions of the oscillating member *R* are shown by the dotted and the full lines, respectively, in the diagrams.

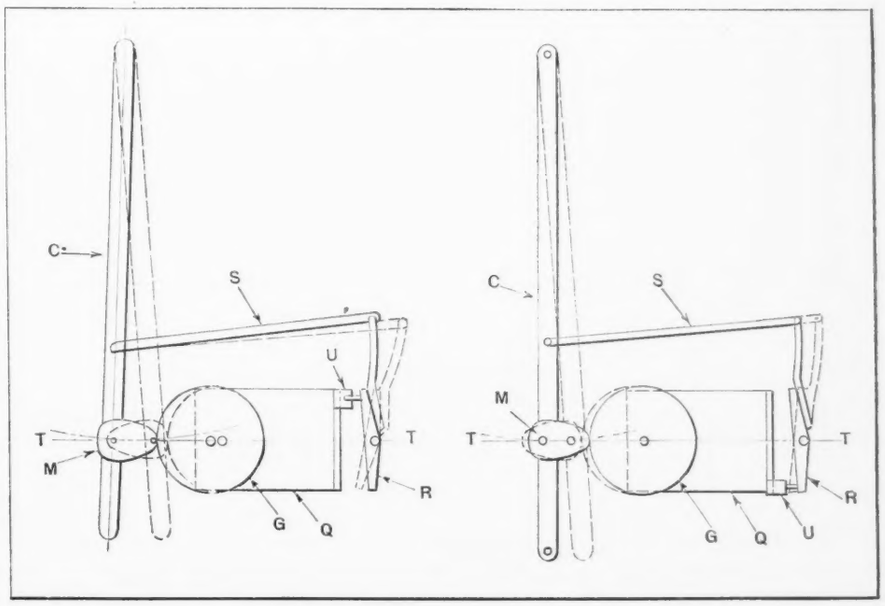


Fig. 3. Lever Mechanism for Controlling Diameter of Formed Work

With the contact member *U* raised to the upper limit, the model wheel is given an additional forward movement or travel to the left. With the contact *U* in the lower position, as indicated in the view to the right, the result would be the opposite of that obtained with the member *U* in the upper position. All degrees of variation from the model, with respect to the diameter and the length, are obtained by intermediate settings of the levers.

The cutter carriage receives its drive from the worm-wheel feed shown at the front of the machine, Fig. 1. The traverse of the model carriage *B* is controlled from the cutter carriage by lever *J*. The contact face of the oscillating member *R*, Fig. 3, is long enough to take care of the maximum travel of the model carriage.

The requirements for shoe-last turning are met by the ten different sizes that can be produced by using a single model. That is, lasts five sizes larger and five sizes smaller than the model may be produced in both rights and lefts. The lever method

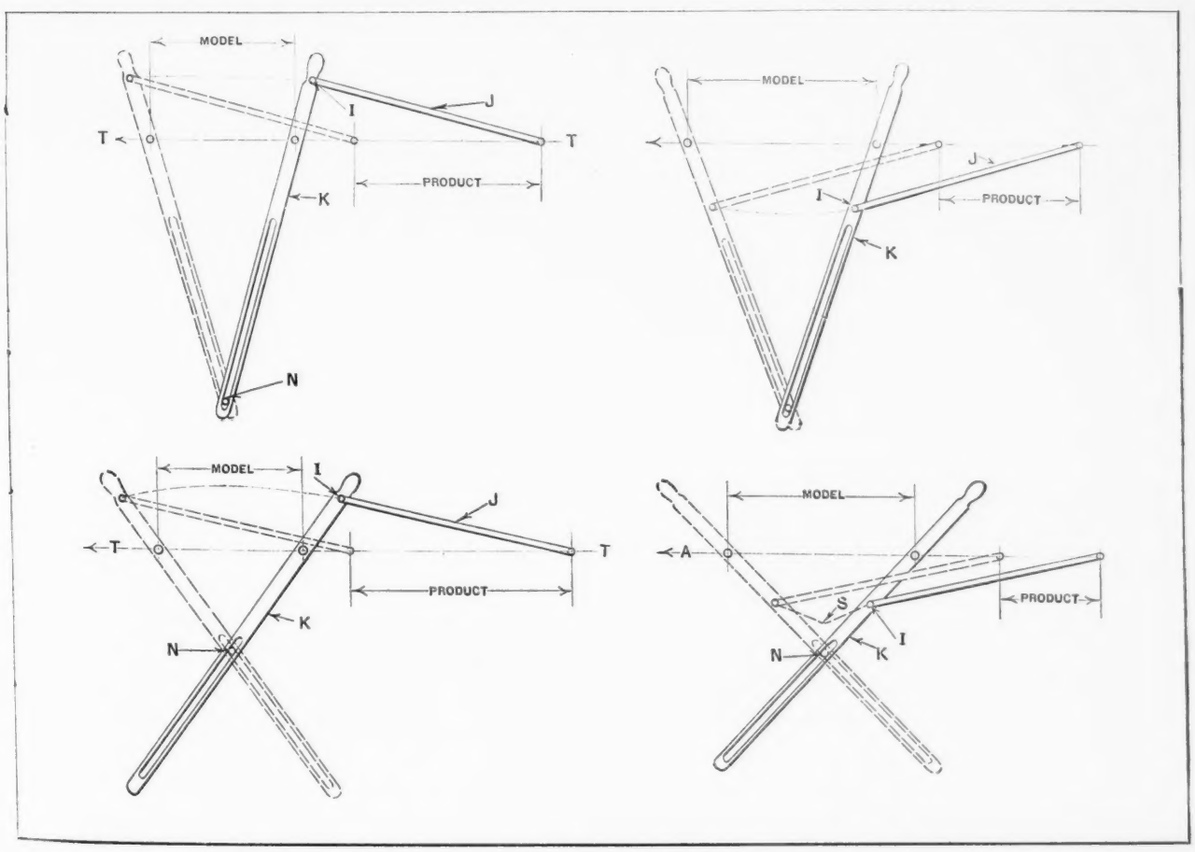


Fig. 2. Proportional Lever Arrangements for Controlling Length of Lasts Formed on Machine Shown in Fig. 1

of obtaining proportional movements was incorporated in an invention of Thomas Blanchard, who secured a patent about 1830 and a renewal which extended his rights to about 1870. This invention, originally designed for gun-stock turning, has been applied by Mr. Blanchard to various other machines, the best known of which is the shoe-last turning machine described in this article.

* * *

ADVERTISING EXPENDITURES

In a paper entitled "How Much to Spend for Publicity and How to Spend It," by G. W. Morrison, publicity manager of the Ingersoll-Rand Co., New York City, read before the annual convention of the National Industrial Advertisers' Association, the author presented some interesting figures based on data furnished by forty-two representative industrial companies. These figures showed what is being done by these companies in promoting sales through publicity. The reporting companies range all the way from those doing an annual business of less than $2,000,000 up to those doing a business of about $30,000,000. According to Mr. Morrison's figures, the advertising appropriation of these companies was distributed as follows:

Trade paper space	$40.10
Art work and engravings for advertisements	6.59
Sales and service literature	10.69
Conventions and exhibits	3.89
Photographs and moving pictures	2.35
Direct mail campaigns	11.61
House organs	3.76
Salaries	9.23
Miscellaneous	11.78

Mr. Morrison also mentioned that during the current year probably $780,000,000 will be spent by industry for advertising in various forms. In conclusion he said: "Since the war, competition in practically every line of industry has become so keen that the cost of selling has increased to unheard of heights, and there is no other problem that many executives are studying so closely today. Everything possible is being done to keep this item from going higher, and, if possible, to lower it. Advertising is being called upon more and more to break down sales resistance, to keep the trade posted on what products are available, and to point out the outstanding features of all kinds of technical products; and it is quite probable that as publicity becomes more and more of a science, it will have a real tendency to start selling costs on a downward trend. Never before has so much thought and care been required in planning advertising campaigns; and never has advertising improved as it has during the last five years."

Lubrication Troubles in Bearings

Only a few years ago, almost all oil-lubricated journal boxes were provided with catch pans, oil guards, and deflectors to prevent the oil from being splashed about. The advent of high-speed machinery increased the tendency of bearings to sling oil, and as a result this difficulty was given a great deal of attention by engineers. Various means have been devised for overcoming this trouble. In an article, "How to Eliminate Lubrication Troubles in Bearings," to be published in January MACHINERY, Herbert A. Freeman will deal with the causes of oil slinging and leakage from bearings, and will outline the remedies that may be effectively adopted. These articles will be of value and interest both to the designer and to the shop executive, foreman, maintenance man, and machine operator. Mr. Freeman deals in this article not with generalities, but with specific remedies, illustrated by many drawings.

THE VALUE OF ASSOCIATION MEMBERSHIPS

Some time ago, in the *Bulletin of the American Society for Testing Materials*, the vice-president of a large industrial corporation outlined the method by which an association is evaluated before his organization takes out membership in it. Definite tests of general application to any association or society, are made use of.

First, the association is evaluated with respect to its economical and ethical objectives. The constitution and by-laws give the avowed purposes of an organization, the members and the institutions represented are a warrant of the execution of the purposes, and their past accomplishments and current activities are an evidence of their good faith.

The second test is that of evaluating the association from the standpoint of what it may contribute to the member. No corporation should assume the responsibilities and expense of membership unless it can expect either a direct or an indirect return. This again can be judged from the objectives of the association, from its record of accomplishments and from the complexion and personnel of the membership. It is further asked what would the corporation receive through the contacts made, through the exchange of information and ideas, and through the education of its participating employe members. Through contact with others engaged in the same work, an employe should gain a broader conception of his job, see its place in industry and realize its possibilities.

It is then asked what could the corporation contribute to the association that would be of value to the other participating members. The benefits to be secured are then weighed against cost of membership fees and the time of executives spent in attendance at meetings and in the preparation of data for these meetings.

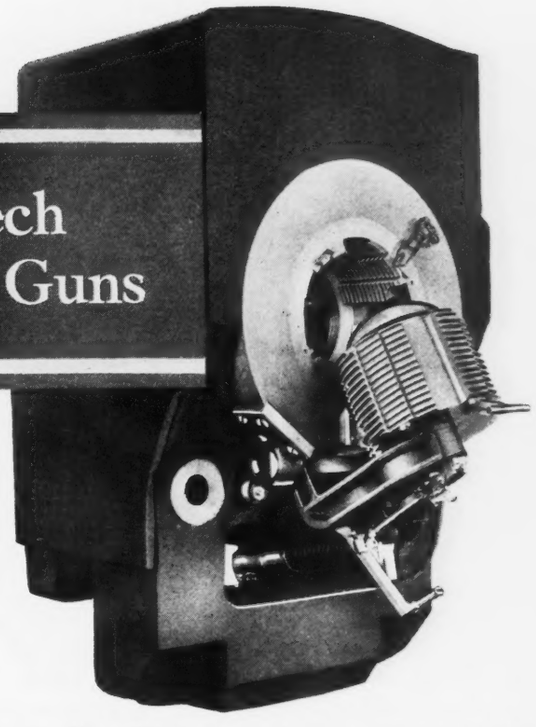
The criteria or tests set forth by this corporation executive are of especial interest. No society is worthy of support unless it can justify its purposes and the expense involved in accomplishing those purposes.

Particularly significant is the question as to what a member could contribute to the association. The value of a society depends in large measure upon the work it does, and this, in turn, depends on the activities of the individual members. It has often been said that a member gets out of a society exactly what he puts into it.

* * *

Non-metallic gears have been successfully applied where pitch line velocities of from 7000 to 14,000 feet per minute were required.

Machining the Breech Mechanisms of Large Guns



Machine Shop Operations of Unusual Interest Performed at the Watervliet Arsenal

By CHARLES O. HERB

ALL the cannon used by the military and naval forces of the United States up to the end of the Civil War were of the muzzle-loading type and had smooth bores. With the adoption of the rifled bore, the purpose of which was to revolve the projectiles during their passage through the air, thus increasing the accuracy of firing, the development of breech-loading guns began. This type of gun became necessary in order to provide an effective seal against the escape of powder gases along the rifling grooves and to create a positive driving force for rotating the projectile when the gun was fired.

Satisfactory breech mechanisms must be of interchangeable construction, so as to permit quick replacements when necessary, and they must be safe and quick-operating. The design varies considerably in the different types of guns, but all breech mechanisms must be finished within close limits of accuracy. Many machining operations of unusual interest are performed in the production of breech mechanism parts at the Watervliet Arsenal, Watervliet, N. Y., some of which are described here. All large guns (from 37 millimeters to 16 inches in size) are made at this Arsenal for the War Department, while some large guns are also made for the Navy Department.

The heading illustration shows a model of the breech mechanism for a 14-inch gun. It will be seen that the breech block is supported by a carrier which swings in a vertical plane on hinge pins. When assembled in a gun, the carrier is normally actuated by compressed air to move the breech block into the breech bushing, and vice versa, but the breech block can also be operated by hand. As the breech block is swung into the recess of the bushing, two rollers near the rear of the block engage cam surfaces in the recess and thus control the block movement. After the block has been smartly swung into the bushing, it automatically rotates into a locked position. Clearance is cut on the bottom side of the breech bushing recess to permit swinging the block into and out of place. A spring counterbalances the breech block and carrier so that the mechanism can be easily operated by hand.

Cutting the Threads of Breech Blocks and Bushings

An operation of particular interest consists of cutting the threads on the various steps of breech

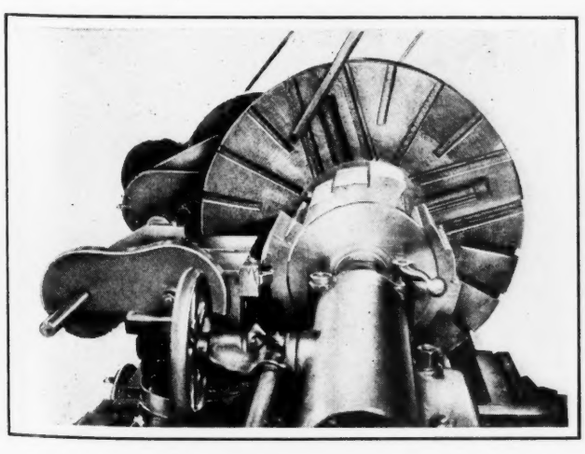


Fig. 1. Step Threading Operation on the Breech Block of a 16-inch Gun

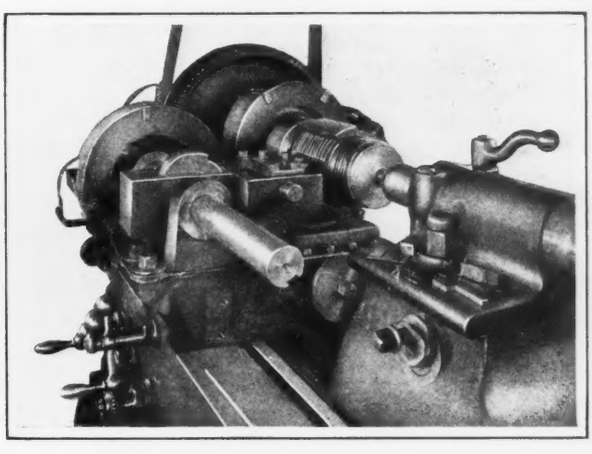


Fig. 2. Another Step Threading Operation, Showing the Controlling Cam

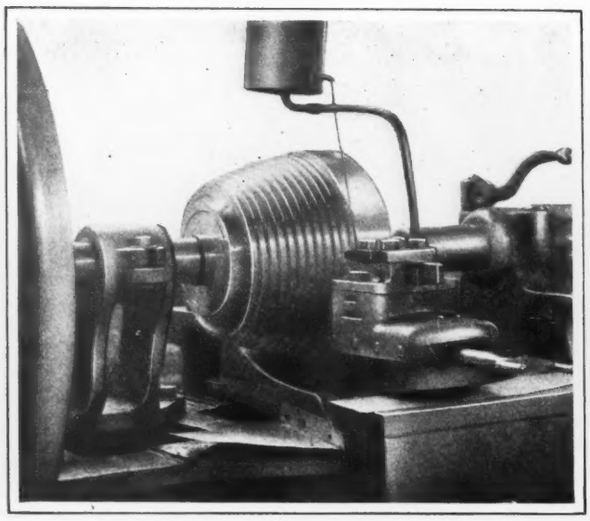


Fig. 3. How the Threads are Cut on a Spherical Breech Block

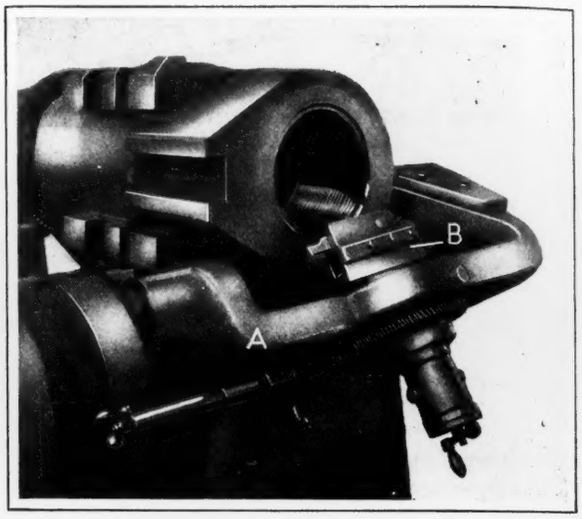


Fig. 4. Machining the Breech Block Swing Clearance in a Breech Bushing

blocks such as shown in Fig. 1. On the periphery of this part there are four series of threaded steps having three steps each, the steps of the different series corresponding in diameter. This operation is performed by means of a single-point tool in an engine lathe, which has been modified by replacing the compound rest slide with a housing that carries a sliding tool-holder and a stepped cam. The cam is mounted on a splined shaft driven from the headstock by gears of such a ratio that the cam revolves four times for each revolution of the headstock spindle.

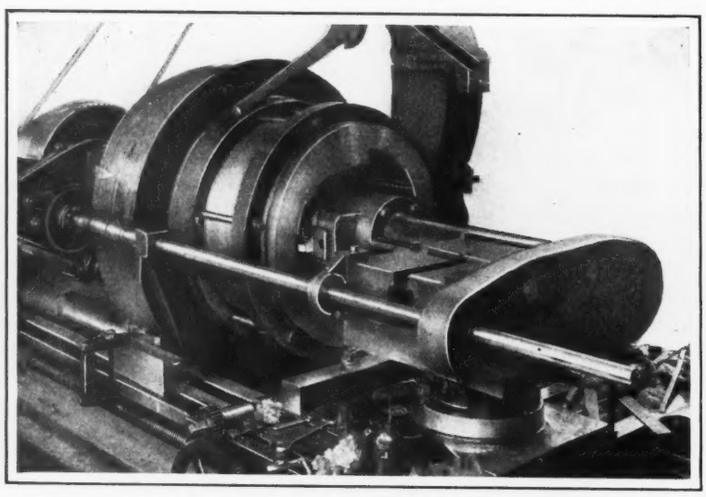


Fig. 5. Equipment Employed in Cutting the Internal Threads in a Breech Bushing

There are three steps on the cam, the heights of which are equal to the differences between the heights of the threaded sectors of the breech block. The rear end of the tool-holder is kept in constant contact with the cam by spring pressure. When the thread tool engages one of the three lowest threaded steps of the breech block, the tool-holder bears against the highest step of the cam. At the instant that the thread tool reaches the small clearance groove between this step and the intermediate one, the high point on the cam passes out of contact with the tool-holder. This permits the spring instantly to snap the tool-holder outward into line for cutting the thread on the second or intermediate step. The same action occurs when the clearance groove between the second and third steps is reached. After the tool has passed the highest threaded step, the cam gradually advances it into position to cut the lowest step of the next series.

With this equipment, the operation is carried on continuously until completed. The carriage, of course, advances toward the headstock during the operation to give the proper lead to the threads. The actual time required to cut the threads on a 16-inch breech block of the type shown in Fig. 1 is about 175 hours. The threads are 0.5 inch deep and of 0.9 inch pitch.

The construction of the cam used in this operation is similar to that seen in Fig. 2, which shows an operation of the same type being performed on a much smaller breech block.

Cutting the threads in a breech bushing that mates with a breech block similar to that shown in Fig. 1 is accomplished by means of the mechanism illustrated in Fig. 5. This mechanism functions in the reverse manner to that used in machining the

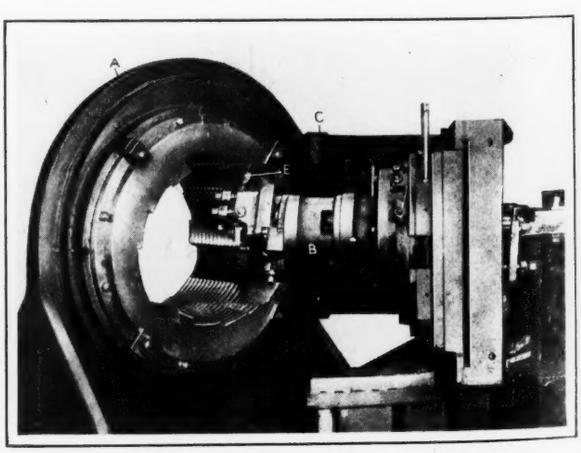


Fig. 6. Method of Producing the Curved Breech Block Clearance in the Breech Bushing Recess

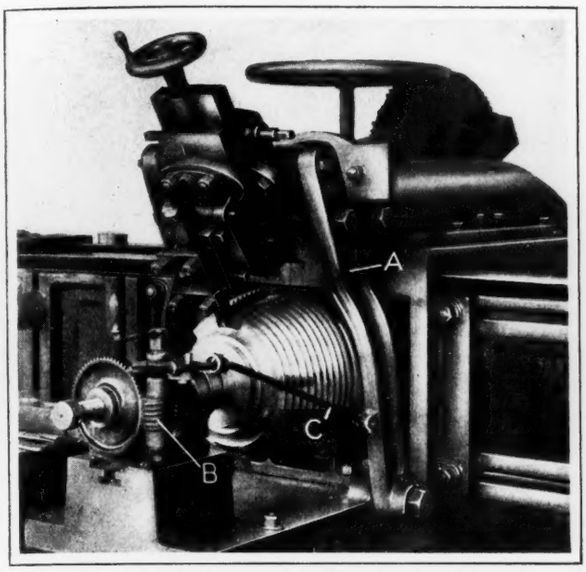


Fig. 7. Shaping the Slots Between the Threaded Sectors of a Spherical Breech Block

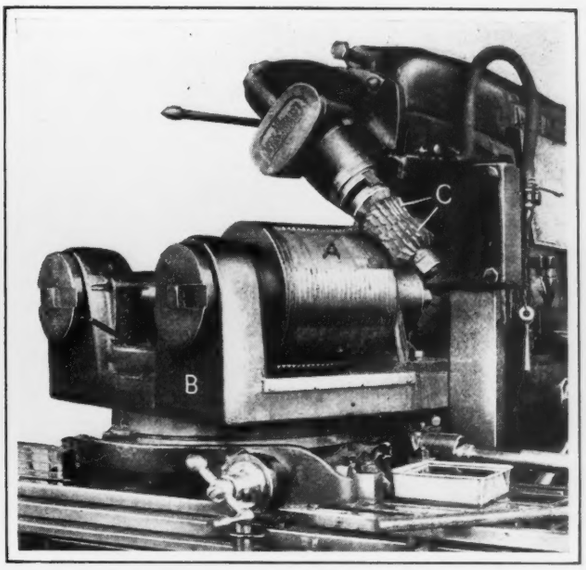


Fig. 8. Milling the Slots Between the Threaded Sectors of Breech Blocks with Form Cutters

breech block. For the threading operation, the bushing is screwed into two threaded portions of a chuck fixture which engages the threads cut on the outside of the part for assembly into the gun proper.

Some breech blocks are of the spherical type shown in the lathe in Fig. 3, and the threads must be produced to the radius of the part and also to the prescribed lead. The threads on this type of breech block are similar to buttress threads. The tool-rest of the lathe employed in threading this kind of breech block is pivoted to a stationary member at the rear of the lathe in such a manner that as the tool-slide is moved with the carriage along the front of the machine, it swings to cut the threads to the desired radius.

Producing the Swing Clearance in Breech Bushings

Various methods are employed for machining the clearance in the recess of breech bushings to permit of swinging the breech block in and out, as already explained. Fig. 6 illustrates the method of cutting this clearance in the breech bushing of a 16-inch gun. The breech bushing is mounted in a fixture *A*, positioned in front of a shaper at an angle with the shaper ram. Interposed between this fixture and the shaper is a tool-head *B*, which is mounted on a base that swings on a shaft *C*. This shaft is held in lugs cast to fixture *A*. The base to which tool-head *B* is attached is connected to the shaper ram. The shaping tool *E* is properly set in relation to the surface to be finished on the work by making suitable adjustments of the tool-head.

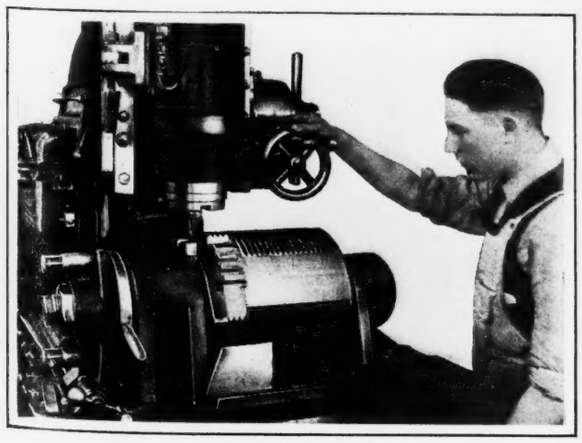


Fig. 9. End-milling Slots, Flats, etc., in a Breech Block

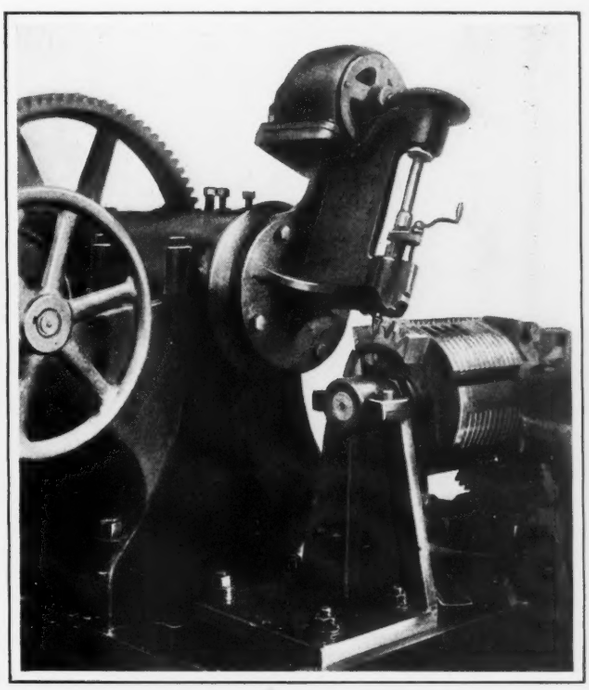


Fig. 10. Unusual Set-up Employed in Milling Several Spiral Teeth on the End of a Breech Block

In operation, the shaping tool is carried at the desired radius back and forth over the breech block as the shaper ram reciprocates and causes the tool-head and the casting on which it is mounted to swivel about shaft *C*. After each return stroke of the shaper ram, the tool-head swivels on its horizontal axis so as to gradually carry the tool around the breech bushing surface.

The method of cutting the breech-block swing clearance in the breech bushing of a 240-millimeter (9.4488-inch) howitzer is shown in Fig. 4. For this operation, the tool-block is mounted on a bracket *A*, which swings on trunnions to permit the clearance surface to be machined to the proper radius. Tool-head *B* also swings on its axis to carry the tool from side to side across the clearance surface. During the operation, the tool-head swings a slight amount on its axis with every oscillation of bracket *A*, so as to position the cutter properly for the next forward movement. The operation is performed automatically after the tool has been positioned accurately by hand.

Machining the Slots Between the Threads of Breech Blocks

Fig. 7 shows an interesting operation, which consists of cutting slots between the threaded segments of a spherical breech block for a 6-inch gun. The shaper employed is equipped with a tool-head, mounted on two links *A*, only one of which is visible in the illustration. The tool-head is also connected to the shaper ram. Thus, at each forward stroke of the ram, the tool is swiveled downward at the desired radius over the surface to be machined. At the end of each return stroke of the ram and tool-head, the feeding mechanism *B* is actuated through rod *C*, swiveling the work on its axis a slight amount to provide the proper feed for the next cut.

On some breech blocks, the slots between the threaded portion are milled; Fig. 8 shows such an operation. The work *A* is held on the trunnions of a fixture *B*, which is mounted on the table of a milling machine, and the operation is carried out by means of two form cutters *C*. Fixture *B* moves gradually toward the cutters in the operation. The fixture is of double design, so that a breech block may be loaded on one side while a block held on the opposite side is being machined.

Many breech blocks have small slots, flats, etc., to be machined. These are often produced by end-milling in a manner similar to that illustrated in Fig. 9. In the operation shown, the work is mounted on an accurate indexing head, which provides a convenient means of positioning the work for the successive cuts.

Milling Spiral Teeth on Breech Blocks

Breech blocks of a 12-inch mortar are rotated by the spiral teeth of a combined spiral and spur gear after they have been entered into the recess of the breech bushing. This combined gear meshes successively with spur and spiral teeth machined on the breech block. Fig. 10 shows the method of cutting the spiral teeth. The spur teeth are visible between two of the threaded sectors. These spur teeth insert the breech block into the bushing and withdraw it.

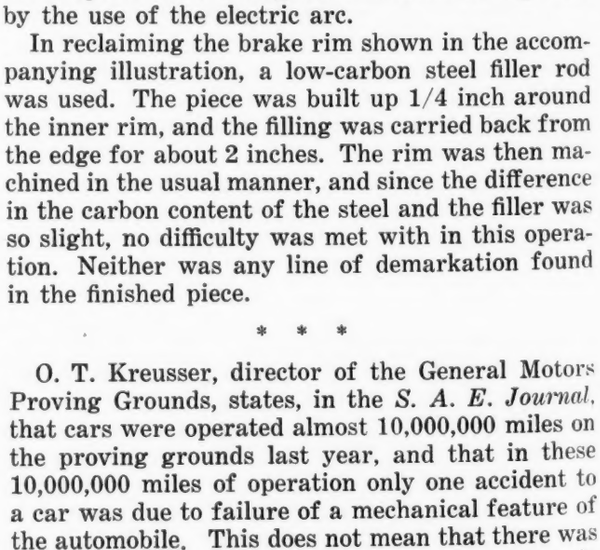
The machine illustrated in Fig. 10 is a boring machine with a special tool-head applied to the main spindle. This tool-head is equipped with a separate motor for driving the tooth-forming milling cutter. In this set-up, the axis of the main spindle corresponds to the axis of the combined gear that is to mesh with the spiral and spur teeth when the breech mechanism is assembled. Adjustments provide for readily setting the milling cutter to take the proper depth of cut.

The breech block is supported on an arbor on the table of the machine, and is rotated on its axis by gears that receive power from the main spindle. At one end the arbor is threaded to screw into the arbor support, this thread being of the same lead as the lead of the spiral teeth to be produced. Hence, as the breech block rotates on its axis it is also advanced longitudinally in relation to the milling cutter, so as to produce the desired helix angle on the teeth. Rotation of the main spindle and work, in setting up the machine, is accomplished by means of a large handwheel.

* * *

RECLAIMING A BRAKE RIM

A new use for arc welding has been found in the reclamation of large steel pieces that are not perfect as they come to the shop. Many pieces that



Reclaiming a Brake Rim by Welding

would otherwise be scrapped are now reclaimed at the shops of the Westinghouse Electric & Mfg. Co., by the use of the electric arc.

In reclaiming the brake rim shown in the accompanying illustration, a low-carbon steel filler rod was used. The piece was built up 1/4 inch around the inner rim, and the filling was carried back from the edge for about 2 inches. The rim was then machined in the usual manner, and since the difference in the carbon content of the steel and the filler was so slight, no difficulty was met with in this operation. Neither was any line of demarkation found in the finished piece.

* * *

O. T. Kreusser, director of the General Motors Proving Grounds, states, in the *S. A. E. Journal*, that cars were operated almost 10,000,000 miles on the proving grounds last year, and that in these 10,000,000 miles of operation only one accident to a car was due to failure of a mechanical feature of the automobile. This does not mean that there was only one failure of mechanical parts, but that only one accident in 10,000,000 miles was due to such a failure.

Developing Men to Assume Responsibility

By WILLIAM A. ROCKENFIELD, Vice-president, High Speed Hammer Co., Rochester, N. Y.

IN an earlier article, which appeared in October MACHINERY, "Getting the Most Out of Men," the writer pointed out a few of the fundamental principles that should guide a chief executive in dealing with his working force, if he expects to obtain the best possible results in initiative and efficiency. In the present article some additional thoughts on this subject are brought out, especially with a view to pointing a way to developing men to assume responsibility.

To Develop a Man, Give Him a Job to Do and Let Him Do It

I know of only one way in which the latent possibilities of any man can be developed, and that is by giving him a job to do and telling him to go ahead and do it. Be careful not to suggest to a man that he should be fearful of failure. Rather, by your confidence in him, teach him that he should be ashamed of failure as a thing that is unnecessary and that would result only from his not giving his best to the job. This idea can usually be conveyed to a man by the manner in which a job carrying responsibility is delegated to him.

Ambition to succeed is a natural attribute of all men. Those who do not have this desire are too few to be taken into consideration; most of those who do not seem to have ambition have probably had some experiences that have discouraged them, but proper leadership can revive their desire to succeed. It is of great importance to prevent a man from losing courage because of failure to carry out successfully work that may have been delegated to him. Most great men have had a few failures on which they have built subsequent success. If conspicuous success were demanded in every undertaking of a man as a qualification for leadership, few men would qualify.

A man's emotions are responsible for many of the things that he accomplishes, and a great many successes are not wholly the result of cold scientific logic or deduction. Ambition and emotion usually furnish the incentive—the motive power. Little can be accomplished without imagination and initiative, and the capable manager stimulates initiative as the thing most worth cultivating in a man, because initiative is the source of all progress in industry, at least. A man who is never satisfied with what he has done in the past, but believes that he can accomplish still better things in the future is the man who makes for progress.

How to Stimulate Initiative and Ambition Toward Accomplishment

Mere money or pay is not nearly so much of an incentive to most worth-while men as the joy of accomplishment and the pride of achievement. Hence, giving a man credit is one of the surest means of encouraging him to continue his efforts. This is well illustrated by a conversation that I recently had with a prominent executive. He told me of a period in his life when he was called in to the president of the company and given a responsible position with a large increase in salary, all of which was duly appreciated; but as he looked back upon that period of young pride and ambition, he said that he believed that his determination to fill the new job to the credit of himself and his organization was due in a great measure to the fact that his name and new title were neatly painted on his office door. Titles are often a remarkable stimulus in making a man live up to the implied responsibility. Titles are one of the methods of giving credit to a man and his achievements before the world.

As applied both to men in minor executive positions and to workmen, telling a man "You know that you can do it," will sometimes help him to surprise both himself and you. Your faith in him is an inspiration to him, and he will try very hard to be worthy of your high opinion. This is a primary human trait and is not confined to any one class. Most of us try to live up to our reputation after we have once acquired it. Of course, it is essential that you be sincere in believing that a man can do what you tell him you believe he can do.

An executive must never forget that after any problem has been worked out it may seem simple to everybody. The reason that many things seem hard to accomplish at first is often because no one conceives that possibly the solution is quite simple. Suggesting to a man that you believe that he can do the job also suggests that it is not so hard as to be beyond his ordinary capacity.

How Men Suited for Executive Work Are Selected

An executive must be able to tackle and solve new problems—often problems that are harder than those previously solved. This means that an executive can be developed only by actually being allowed to solve daily problems as they come up. If he is able to solve them correctly, it will show in the cost sheet. Unless men are allowed to solve problems and the results are noted, it is not possible to find out whether they are executive material or not.

An executive is supposed to differ from other skilled men in his ability to see beyond today and to anticipate and plan for the future. Such ability can be developed only by doing things. One really cannot teach a man to do anything. One can only guide and advise him, but he must have the opportunity of teaching himself by actually doing the work in which he is to become proficient.

The most successful manager is not the one who tells everybody how each detail of the work should be done, but rather a man who acts as a kind of court of review or of final approval on the method

decided upon by those who are to do the work. The man who tries to do everything himself soon finds that he is buried in work that his subordinates should do, and what is worse, he naturally surrounds himself in the course of time with the type of men who are perfectly willing to let him do the work, as men with courage and initiative are not attracted to that kind of organization.

Simple Things that Encourage Cooperation and Loyalty

It will never be possible to supplant the direct contact of an executive with the efforts of a personnel manager. It cannot be done. A daily walk through the shop by the man in charge is worth more than many well intentioned "welfare" methods. I recently accompanied an executive from his office to his automobile. He walked around two sides of the plant, when he could have saved a great deal of time if he had walked directly through the shop; but more important, he lost an opportunity to do what he ought to do.

Every man wants to be liked and likes to be recognized. The man in the shop is no different in this respect from the chief executive. Few of us do anything worth while without, in some manner, anticipating respect, credit, or commendation from some source, entirely apart from the payment or profit that may be obtained for doing the work.

In modern industry, an executive has not the time to discuss every question in detail with those working for him. Sometimes he must give orders without explanation; but if an executive is known to be fair and if his judgment is respected, even though the purpose is not clear to the organization, they will always give him credit for having a good reason behind every decision.

A manager's most valuable asset is a reputation for being fair. This reputation must be earned. The manager is always in the spotlight. His actions, example, and attitude toward his work is reflected to the farthest corner of the plant. If he is decisive, courageous, a good planner, and fair in all his dealings, similar qualities will be developed throughout the organization.

The Golden Rule in Dealing With Men

Environment and social status broaden the horizon and leave their marks on a man, but the emotions and general attributes are fundamentally the same in all men. A great many of our executive problems that have to do with men would be solved more easily if we would only remember that we are all made of the same kind of clay—that we are all very much alike.

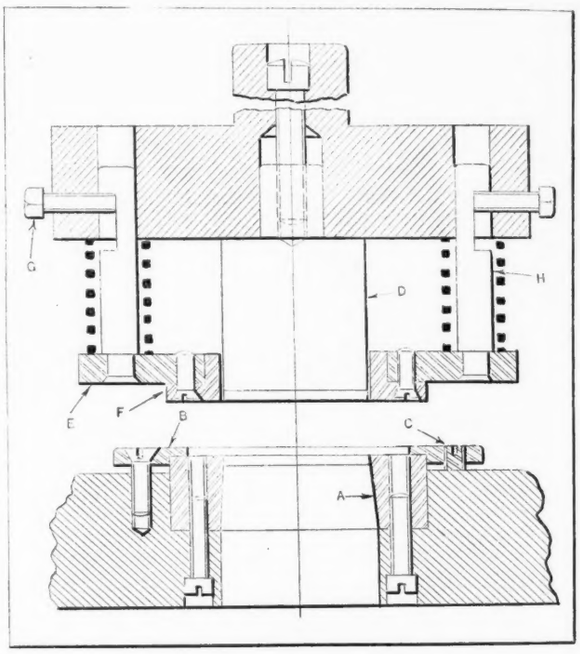
Judging by their actions, some executives seem to believe that the men working for them are of a different species from themselves and seem to persist in thinking that methods by which they themselves would be infuriated or feel insulted can be properly applied to their subordinates. A good application of simple psychology that will assist in answering many questions that have to do with the management of men, is to reverse the situation mentally, and see how you yourself would react in a similar situation if the man you are dealing with were your boss; then act accordingly.

QUICK-CHANGE WASHER DIE

By WALTER E. GUNNERSON

We have found the die here illustrated to be a great time-saver in making odd lots of round blanks or washers. One reason for the saving is the ease with which varying sized punches and dies may be set up, and another is the convenient arrangement for locating the nest for the blanks.

The die *A* is secured in the die-shoe by four fillister-head screws. The hole in the die is concentric with the outside, which simplifies the locating of the nest *B*. The nest is secured to the die-shoe by four flat-head screws. Close to each screw is a headless set-screw *C*, which bottoms on the die-shoe and supports the nest. For straight blanking, of course, a nest is not used.



Punch and Die which can be Quickly Changed to Accommodate Different Sizes of Work

A shank on the round punch *D* fits in the punch-holder and is held there by a fillister-head screw. The stripper *E* is made in two parts; the outer part to which the pins are fastened is standard, and used for all sizes of punches, while the inner part *F* is interchangeable, as its center hole must vary according to the size of the punch used. Part *F* is fastened to *E* by three flat-head screws.

In setting up the die, the screws *G* are loosened and the stripper and springs removed. When the punch and die are lined up, the stripper is put over the punch, the punch press ram brought down to compress the stripper springs, and the screws *G* screwed into the grooves in the guide pins *H*.

* * *

In one razor blade plant, seventeen miles of steel ribbon are stamped into razor blade blanks every day. This represents two million blades, which are finished the same day. Without counting cleaning, drying and wiping, 24,000,000 operations are required to grind, hone, and strop the two edges of these two million blades.

FURNACES AS PRODUCTION EQUIPMENT

By E. G. DE CORIOLIS, Surface Combustion Co., New York City

Heat-treating furnaces are important links in the production equipment of many manufacturing plants. Production managers are gradually coming to realize that there is no difference in principle between a heating operation and a purely mechanical one. Both involve the expenditure of energy in performing useful work, and equal care should be exercised in designing the equipment for each. The outstanding difference in practice, however, lies in the method of applying heat energy, as contrasted with mechanical energy.

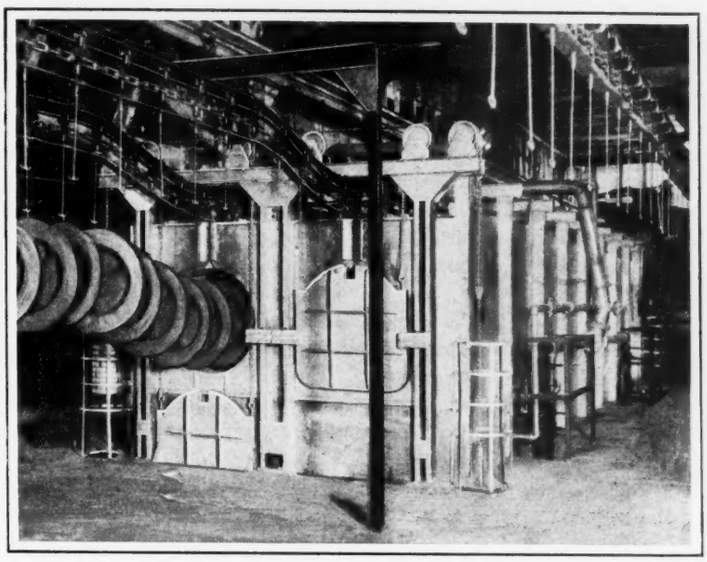


Fig. 1. Continuous Annealing Furnace

While the arrangement of machine tools in line formation, so that the work travels along as smoothly as possible from the rough to the finished or assembled stage, is common practice, both in large and small shops, there are many plants in which properly designed heat-treating furnaces have not yet been included in the line-up of equipment. In many cases, this is a serious handicap, and constitutes a greater hindrance to production than is generally realized. No production manager would continue to use old inefficient heat-treating furnaces located in some out-of-the-way corner if he fully realized the improvements in quality and production rates obtainable with modern automatically controlled heat-treating furnaces.

The modern gas furnace is employed to produce changes in the surface, the interior structure, or the composition of an object or substance, by the proper application of heat energy. In order to fulfill its requirements satisfactorily, a heat-treating furnace must be carefully designed by men experienced in such work. Rapid progress has been made in developing mechanical devices or feeds for handling the work. These not only cut down labor costs, but also give more uniform control over the heat-treating processes.

In designing an automatic gas furnace, a coordinated knowledge of the following factors is essential:

1. Principles of combustion and combustion systems.
2. Application of correct burner equipment for the particular operation and the composition of the gas available.
3. Mechanisms of combustion control.
4. Effect of atmosphere on the particular product.
5. Mechanisms of thermostatic control.
6. Nature and behavior of refractories.
7. Nature and behavior of metals and alloys.
8. Mechanisms for propelling, conveying, or otherwise handling the product.
9. Principles of construction and assembly.

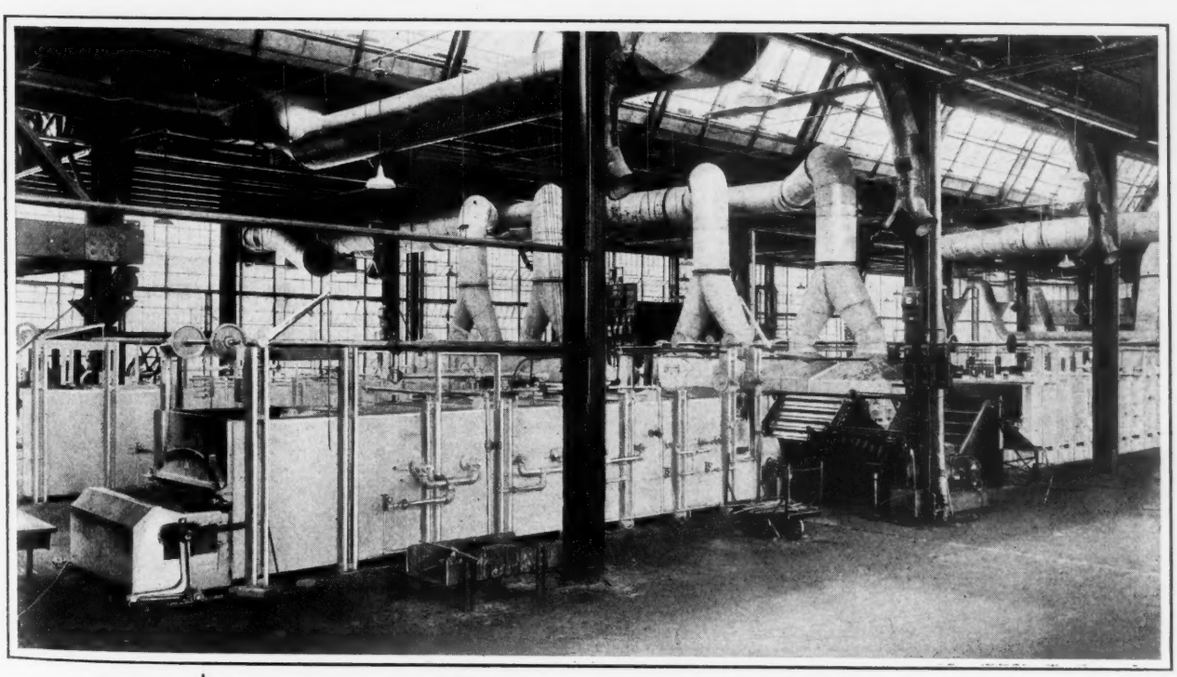


Fig. 2. Furnace Equipment for Hardening Automobile Springs

10. Complete understanding of the process and the product.

The greatest progress in furnace development has been made where there has been close co-operation between the specialists in the plant, who are fully conversant with the requirements of the product, and the specialists in combustion engineering, who through their knowledge and experience with gas furnace construction and operation are best able to interpret the requirements and incorporate them in correctly designed equipment. Furnaces for low temperatures, such as are required for tinning and for annealing non-ferrous products, as well as furnaces for higher temperatures used in hardening, are provided with thermostatic controls, which hold the temperatures within very close limits.

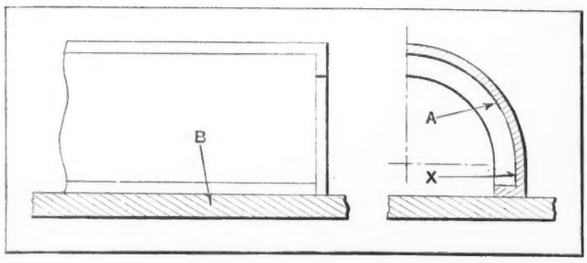


Fig. 1. Aluminum Casting of Quadrant Construction Machined by the Use of Two Lathes

In Fig. 1 is shown a gas furnace installation of the continuous counterflow annealing type. The illustration shows the clean-cut design of the furnace and the details of the conveyor system that handles the work. The furnaces shown in Fig. 2 are employed in hardening and drawing operations on automobile springs.

A recent development in automatic heat-treating equipment is a conveyor belt of thin metal. The work is fed on this metal belt and is carried to the high temperature zone of the furnace, after which it is discharged into a sealed quenching tank from which it is automatically ejected.

* * *

AN INGENIOUS LATHE SET-UP

Considerable ingenuity was required in the solution of a machine shop problem that arose some time ago at the Watervliet Arsenal, Watervliet, N. Y. The problem consisted of finishing surface *A*, Fig. 1, of an aluminum quadrant casting. This casting was of thin circular cross-section, and had flanges at each end and lengthwise along one edge. Surface *X*, which extended the full length of the casting between the end flanges, was first milled to the required depth.

Two lathes were employed in the operation of finishing surface *A*, as illustrated in Fig. 2. The casting was seated on plate *B*, which was attached to the cross-slide of one of the lathes. Bar *C*, in which a boring tool was mounted, was placed between the centers of the headstock and tailstock, with sufficient freedom so that it could be easily rotated backward and forward on the centers. This bar was also supported by V-blocks on plate *B*.

A dog *D* clamped to the right-hand end of bar *C*, was connected to chuck *E* of the second lathe through rod *F* and the slotted link *G*, this link being bolted to the face of chuck *E*. The end of rod *F*, attached to link *G*, could be adjusted along the link to change the distance from the rod to the center of the lathe chuck and thus increase or decrease the crank motion imparted to the rod as the chuck revolved.

In operation, the tool was carried over surface *A* of the work as faceplate *E* pulled rod *F* toward it. At the moment when the tool reached the lower end of surface *A*, the end of rod *F* attached to chuck *E* passed over the center of the chuck, and the rod was then pushed toward the front lathe. This resulted in dog *D* and bar *C* being swiveled on the lathe centers, thus returning the tool to the top of the casting. The operator would then revolve the carriage handwheel slightly to feed the work longitudinally in relation to the tool, ready for the next downward movement of the tool.

* * *

In a series of tests, it was determined that the tooth strength of non-metallic gears does not decrease nearly so rapidly with increases of pitch line velocities as the tooth strength of metal gears.

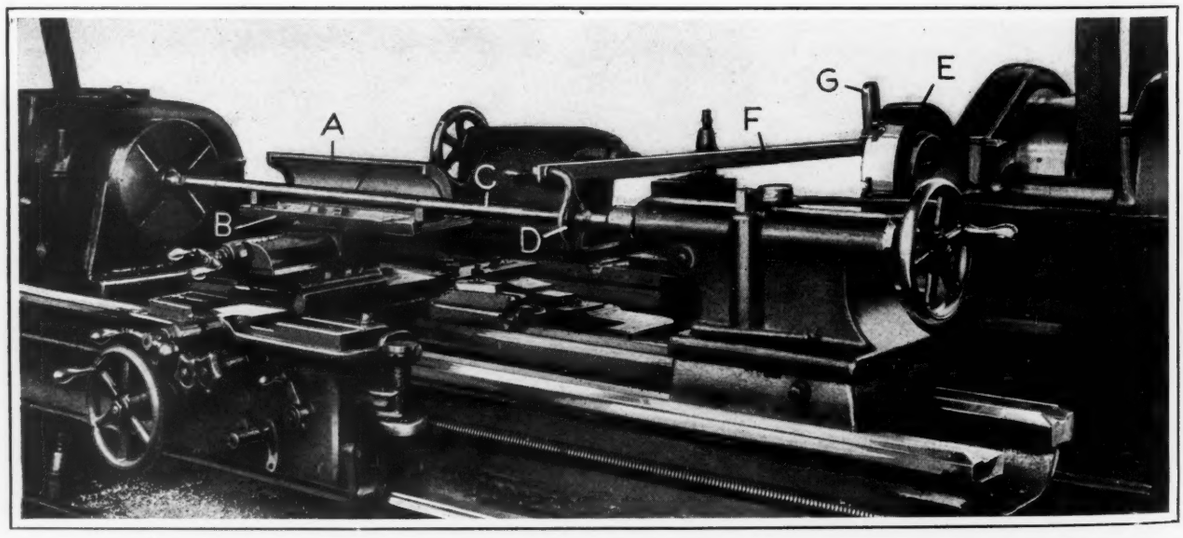


Fig. 2. Two-lathe Operation in which One Machine Imparts an Oscillatory Movement to a Tool-bar Held between the Centers of the Second Machine

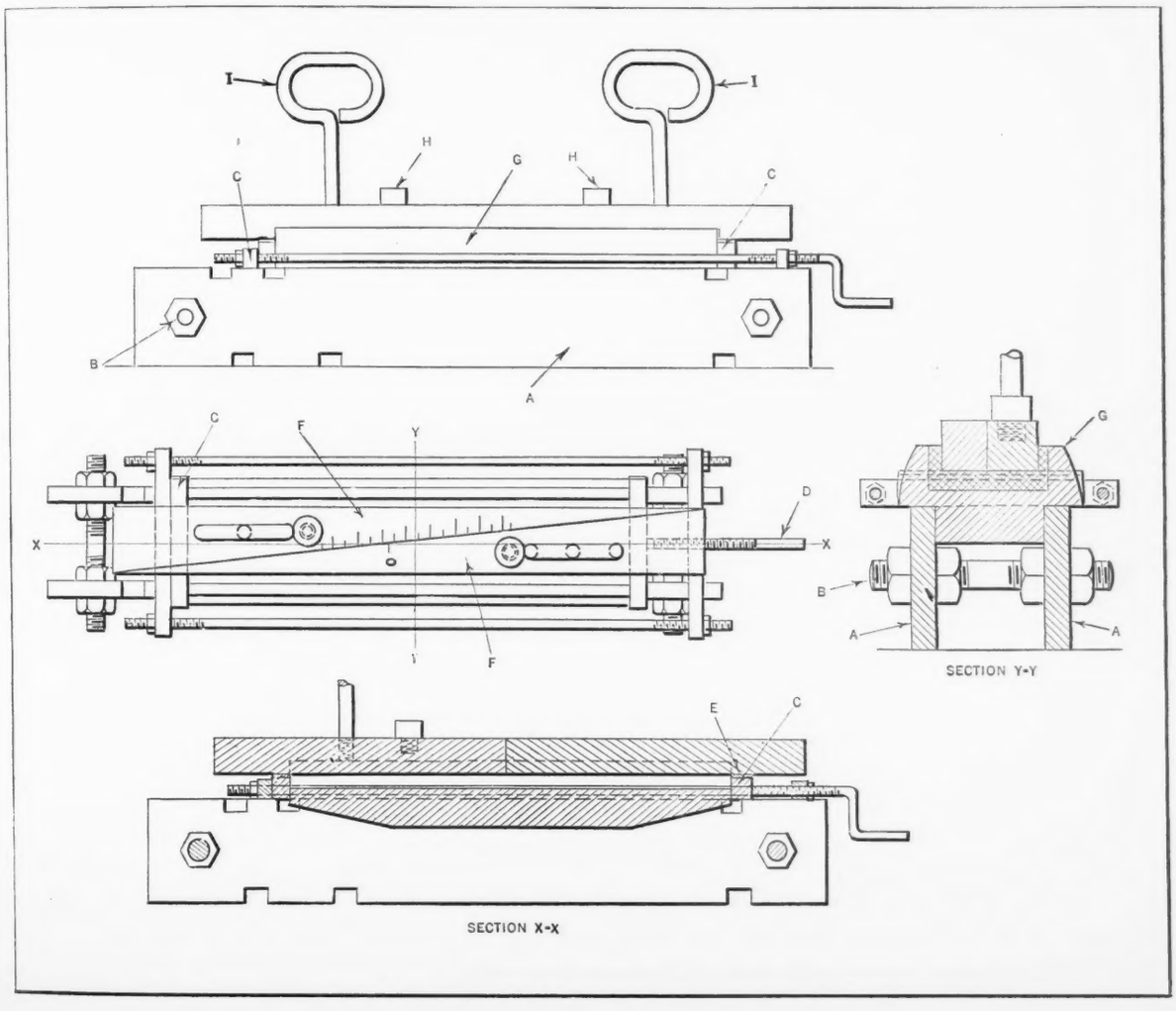
Special Tools for Railway Shops

BABBITTING FIXTURE FOR LOCOMOTIVE CROSS-HEAD GIBS

By WILLIAM G. THOMAS, Chesapeake & Ohio Railway Co.

With the babbitting fixture here illustrated, a cross-head gib can be babbitted in ten to twelve minutes. The bearing dimensions can be made any size required, and no further planing or machining is necessary. This permits the locomotive to be put back in service an hour sooner than would be possible if the old method were employed. As from twelve to fifteen gibs are babbitted in a day of twenty-four hours, a saving of fifteen locomotive service hours is made, aside from the saving of eight hours of labor. A saving of about 20 pounds of babbitt, which would otherwise be lost in the chips when planing the gib, also results from using this fixture, which is the patented invention of the writer.

The fixture has two supporting plates *A*, tied together by bolts *B* and adjusted to hold the gib *G* to be babbitted, as shown in section *Y–Y*. It will be noted that the side pieces *A* are notched on their edges to provide clearance for the ends of the gib, which are often battered or distorted while being removed from the engine. After placing the gib in position, transverse metal blocks *C* are clamped against the ends of the gib by means of the screw *D*. The blocks *C* stop the molten metal from flowing out at the ends of the gibs. The thickness of the babbitt at the bottom of the gib is determined by the height of the blocks *C*. In some cases, filler blocks *E* are placed on the top surfaces of blocks *C* to increase the thickness of the babbitt at this point.



Fixture for Babbitting Locomotive Cross-head Gibs

The wedge blocks *F*, which mold the channel bearing in the gib, rest on blocks *C*. The spaces between the sides of blocks *F* determine the thickness of the side walls of babbitt. Graduations on the wedge blocks *F* enable these members to be quickly set to give any desired channel width. After the fixture is properly set up, the babbitt is poured in at the sides of the blocks. As soon as the babbitt has set or cooled and it is desired to remove the wedge blocks, one of the lugs *H* is struck with a

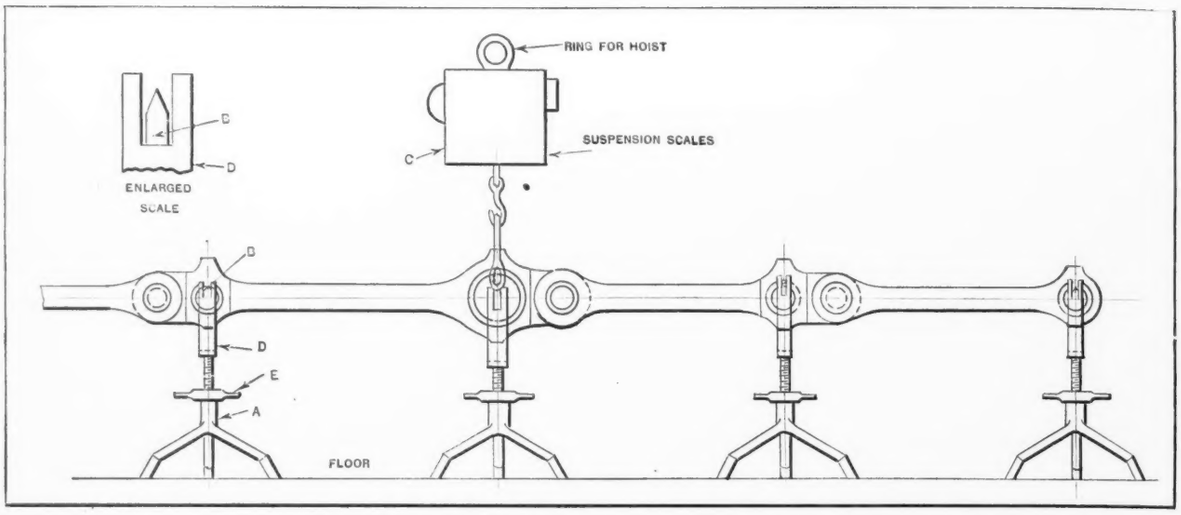


Fig. 1. Diagram Showing Method of Weighing Assembled Side-rods for Counterbalancing at Each Crankpin

hammer, the blow being delivered in the proper direction to cause the blocks to slide away from each other along their diagonal contact faces. The handles *I* facilitate the removal of the tapered blocks.

WEIGHING LOCOMOTIVE SIDE-RODS FOR BALANCING

By J. B. IRWIN, Shop Superintendent, Chicago, Burlington and Quincy Railroad Co.

In Fig. 1 is shown diagrammatically a method employed in the Chicago, Burlington, and Quincy Railroad Shops, Denver, Col., for weighing locomotive side-rods in order to obtain accurate counterbalancing. With this arrangement, the rods are connected and mounted on the stands *A*, with the knuckle pins in place, the nuts tightened, and the cotter-pins inserted, so that the rods carry their full equipment or normal weight.

The connecting-rods are supported at each bearing by modified knife-edge bars *B*, located in slots in the adjustable members of stands *A*. The weighing scales *C*, suspended from an overhead beam or jib crane by a differential hoist, are employed to obtain the weight of the assembled side-rod at each crankpin. The jib crane makes it possible readily to weigh each section of the side-rod separately.

Before weighing the assembled rod, the bearing supports *D* are raised or lowered by means of the handwheels *E* until the centers of the side-rod bearings are all in line. When weighing the rod at any particular joint, the rod is raised slightly out of contact with the knife-edge support *B*, so that the weight is taken with the rod bearings all in line.

After the side-rod has been weighed, a set of chains, such as shown diagrammatically in Fig. 2, is used in connection with an overhead crane to deliver the work to the erecting shop. The five chains are all connected to the hoisting ring *A* as shown. The outer end of each chain is provided with a grab hook, such as shown in the enlarged view at *B*. An eyebolt *C* is screwed into each of the oil-cup holes, and the chain ends are passed through the eyes of these bolts and hooked in place. A turnbuckle, placed in each chain about 2 feet from the crane link *A*, permits the chains to be tightened or loosened, as required, to enable the rod to be placed on the driving pins.

By this method of applying side-rods, a material reduction in time is made, as compared with former practice.

* * *

Donald MacFee, writing in *Power*, tells of a former shoe salesman, now selling coal, who was giving his sales talk to a prospect. "There's no ash in this coal; not a bit of sulphur or dirt. I tell you it's a wonderful fuel."

"How many B.T.U.'s are there in it?" inquired the prospect.

"Absolutely none," was the clinching answer.

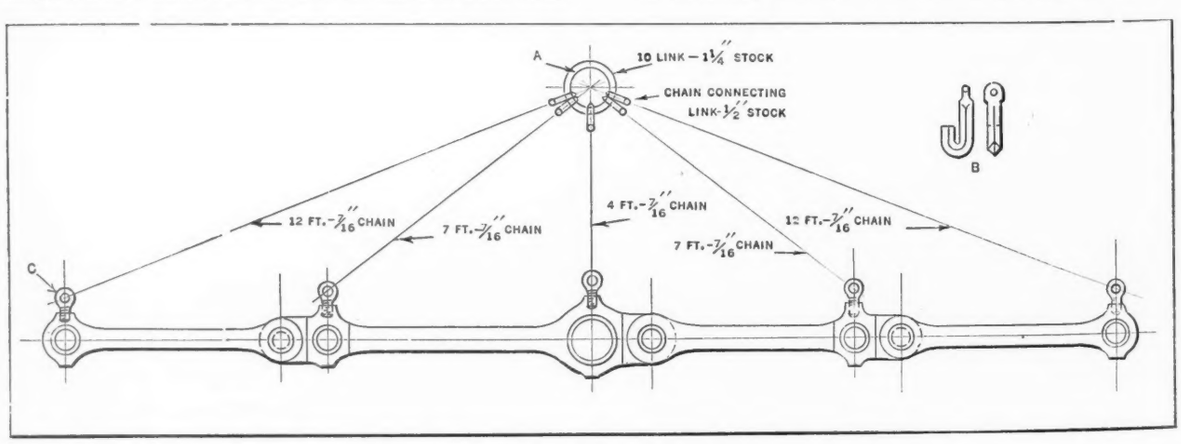


Fig. 2. Set of Chains Used in Handling Assembled Locomotive Side-rods

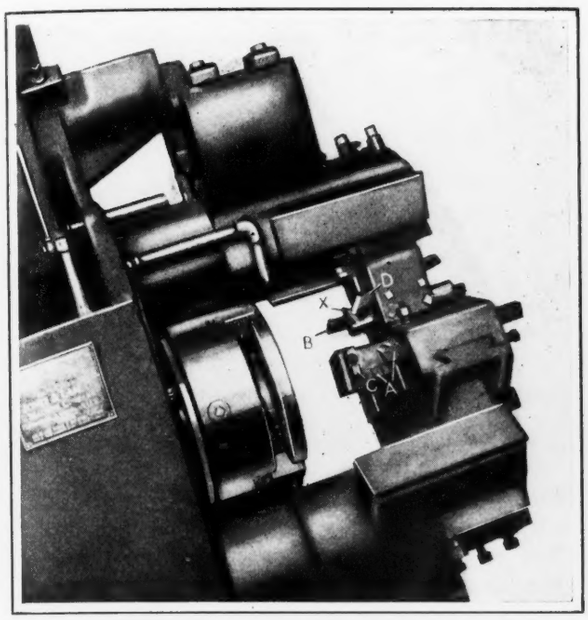


Fig. 1. Taking Turning, Boring, and Facing Cuts on Ring Gears in a Hartness Automatic Lathe

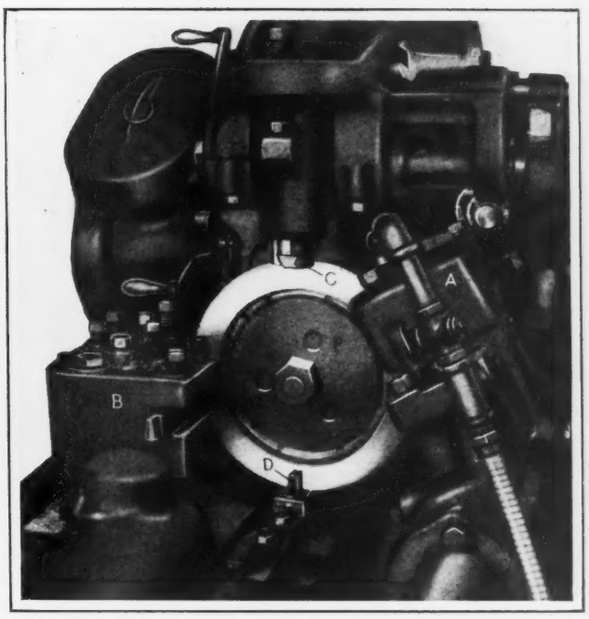


Fig. 2. Finishing the Facing and Turning of Ring Gears in a Fay Automatic Lathe

Producing Automobile Replacement Gears

High-production Methods Used in a Shop that Manufactures Differential Ring Gears and Pinions for Service Requirements

By CHARLES O. HERB

INCLUDED in the automotive industry are shops that specialize in the production of repair parts for automobiles and motor trucks. The Automotive Gear Works, Inc., Richmond, Ind., comes under this classification, as a considerable part of its business consists of making differential ring gears and pinions to meet the service requirements of car manufacturers and automobile service stations. These gears and pinions are produced for practically all makes of automobiles. The methods of machining, heat-treating, and inspecting that are followed insure finished gears as accurate as those that were originally in the car. Some of the more important of these methods will be described in this article.

First Machining Operation on Ring Gears

All ring gears and pinions produced in this plant are upset forgings made of S. A. E. No. 2315 steel containing 3.5 per cent nickel. These forgings are purchased annealed. When an order of forgings is received, a chemical analysis is made to check the composition. The hardness is determined by taking a reading with a Rockwell hardness tester. A typical ring gear is illustrated in Fig. 4, and its mating pinion in Fig. 6.

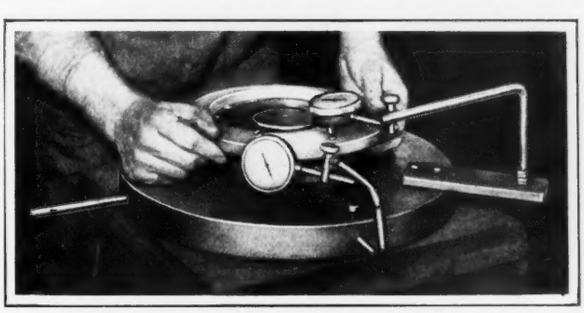


Fig. 3. An Inspection Performed on Ring Gears prior to Cutting the Spiral-bevel Teeth

The first operation on the ring gear blanks is performed in Hartness automatic chucking lathes equipped as shown in Fig. 1, and consists of facing surface *a* (Fig. 4), boring hole *b*, back-facing surface *c*, and chamfering corner *d*. Roughing and finishing cuts are taken on all these surfaces in one operation, with the exception of corner *d*.

The gear blank is held in a three-jaw chuck with the bevel face toward the chuck, as shown in Fig. 1. As the upper head of the machine feeds toward the work, tools *B* and *X* take rough and finish cuts, respectively, on hole *b*, Fig. 4, while tool *D* chamfers corner *d*. This head feeds straight in and returns similarly. The lower head feeds toward the work until tools *C* and *A* are in line, respectively, with the surfaces *c* and *a*, Fig. 4. Then the head rocks sidewise on its axis toward the left for rough-facing these surfaces. Two tools *A* are employed in this operation, in order to reduce the time required for the cut on surface *a* one-half.

At the end of the roughing cuts, the lower head rocks toward the right to carry similar tools on the right-hand side over the same surfaces for finishing them. The head then rocks back again to a central position and withdraws to the front of its arm, after which the machine stops to permit reload-

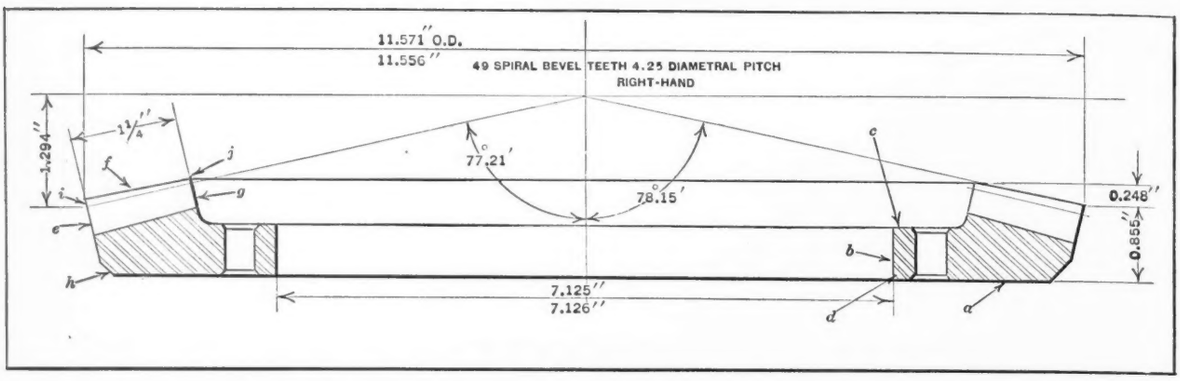


Fig. 4. Typical Spiral-bevel Ring Gear Produced to Meet the Requirements of Automobile Service Stations

ing. From 1/32 to 3/64 inch of stock is removed by the roughing tools, and about 0.010 inch by the finishing tools. The production per machine averages 12 gear blanks per hour.

Hole *b*, Fig. 4, is next broached, so as to produce a true round hole of the desired size and thus permit accurate chucking in subsequent operations. Not more than 0.010 inch of stock is removed on the diameter by the broach. The rivet holes around the inner flange are next drilled on a multiple-spindle machine, after which they are countersunk and burred by single-spindle drilling machines.

Finishing the Opposite Side of Ring Gear Blanks

The gear blanks now reach a Fay automatic lathe, tooled similarly to that shown in Fig. 2, where the remaining surfaces are turned or faced. The broached hole of the blank is seated on a hardened and ground plate attached to the machine spindle, and the blank is clamped to the spindle plate by tightening disk *P* against the inner flange.

In this operation, back arm *A* rocks forward to present tools to the work for rough-facing surface *f*, Fig. 4, and chamfering corner *h*. However, the latter surface is not chamfered until tools on the front carriage have rough- and finish-turned surface *e*. In addition to the tools that rough and finish surface *e*, the front carriage block *B*, Fig. 2, is provided with tools for turning surface *g*, Fig. 4. Corners *i* and *j* are chamfered by the tools used in turning surfaces *e* and *g*, respectively.

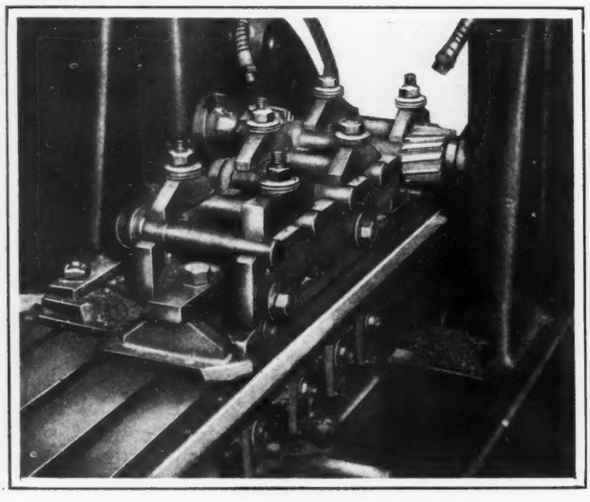


Fig. 5. Milling Automobile Differential Stem Pinions to Length

After surface *f* has been rough-faced by the tool on the back arm, it is finish-faced by a tool mounted in the sliding arm *C*, Fig. 2, of an overhead attachment. This slide feeds the tool across the surface at the proper angle to produce the desired bevel on the gear blank. Tool *D*, which is mounted on a holder attached to the ways of the front carriage, is used for facing a slight flat on inner edge *j*, Fig. 4. Approximately the same amount of stock is removed by the roughing and facing tools in this operation as in the first operation, and the production averages 12 gears per hour.

Inspecting the Machined Gear Blanks

When the ring gear blanks leave the Fay automatic lathe, they are inspected for concentricity, diameter, and thickness by means of the fixture illustrated in Fig. 3. This fixture is equipped with two dial indicators, one of which is brought in contact with surface *e*, Fig. 4, at the pitch line to check the diameter and concentricity of the blank. The second indicator registers on surface *f* and checks the thickness of the blank. The broached hole of the gear blank is seated on a hardened and ground plate which is revolved with the gear. To pass the inspection, each gear blank must be concentric with the bore within plus or minus 0.0015 inch, and the outside diameter must be true within plus or minus 0.0015 inch.

Machining Pinions of the Stem Type

The first operation on pinions of the stem type illustrated in Fig. 6 consists of milling them to length on the Cincinnati automatic duplex milling machine shown in Fig. 5. Six pinions are held in the fixture at one time, resting in vees and being gripped by equalizing clamps. They are located lengthwise from the under side of the heads. The operator of this milling machine also centers each end of the pinions under a single-spindle drilling machine after the parts are unloaded from the miller. The drilling machine is provided with equipment that insures centers of uniform depth in all pinions.

From the centering operation the pinions go to a Fay automatic lathe equipped as shown in Fig. 7, in which they are held on live centers. A chuck of floating design grips the rough taper head of the part for driving it. Seven tools on the front carriage of this machine simultaneously turn surfaces *a*, *b*, *c*, *d*, *e*, and *f*, Fig. 6, two tools each turning

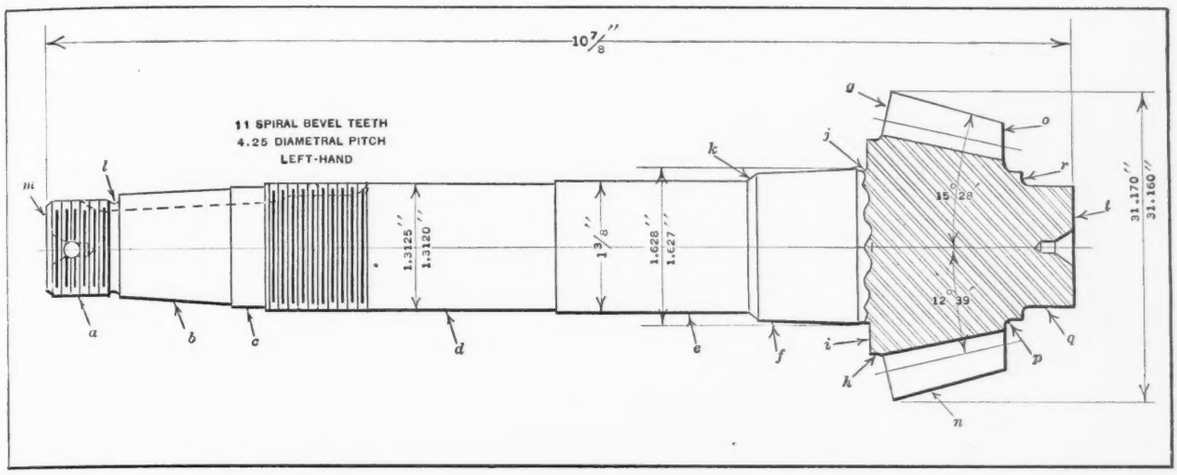


Fig. 6. Spiral-bevel Pinion which Mates with the Ring Gear Shown in Fig. 4

one-half of surface *d* so as to reduce the operation time one-half. The tapered surfaces *b* and *f* are machined by tools held in blocks which are drawn outward by a taper attachment in the proper ratio to their lengthwise movements to produce the desired taper. The tool used in turning surface *f* also takes a roughing cut on the back of the head of the pinion.

When the cuts taken by the front carriage tools have been completed, the back arm rocks forward, bringing a form cutter into contact with the work for simultaneously machining surfaces *g*, *h*, *i*, and *j*. The work shown in the machine in Fig. 7 differs somewhat from the pinion presented in Fig. 6, but in work of the latter type, other tools on the back arm face shoulder *k*, form recess *l*, thread end *a*, and chamfer corner *m*. The production in this operation averages from 25 to 30 pinions per hour.

After the head end of the stem pinions is finished in a Gridley single-spindle automatic, each pinion is placed in an inspection fixture equipped with two dial indicators which are brought in contact with surfaces *d* and *f* while the part is revolved. These surfaces must be concentric with the centers on which the pinion is held, within 0.0015 inch. The various diameters are checked with micrometers. The keyway is next milled on the stem end, the cotter-pin hole drilled, the threads hobbed at one end of surface *d*, and surface *f* is finally green-ground.

Cutting the Gear and Pinion Teeth

Spiral-bevel teeth are cut on both the ring gears and pinions by first roughing out the teeth on Gleason roughing machines and then finishing them on Gleason generators. Standard methods are employed. There are thirty-one Gleason gear-cutting machines in this department. Before the ring gears come to these machines, their backs are ground on a Blanchard surface grinder in a manner to be described later.

Burnishing the Pinion Teeth

All pinions are taken from the generators to a testing machine, in which they are run in mesh with a hardened master gear to determine the character of the tooth bearing surfaces. These tooth surfaces are then burnished in the machine illustrated in Fig. 10, by running the pinion in mesh with a hardened master gear while copiously applying a mixture of white lead and oil to the teeth. The pinion is driven through the master gear, and the head on which the pinion is mounted swivels to and fro during the entire operation to insure a full length contact of the pinion teeth with those of the master gear.

The master gear and pinion are run about two seconds in one direction and then a similar length of time in the opposite direction. When the pinion is removed from the machine, it is again returned to the testing machine to determine the accuracy of the burnished tooth surfaces. In Fig. 10, the guard that covers the work during an operation is shown swung downward to give a clear view of the work.

While a pinion is in the testing machine, defective teeth can be discovered by sound, sight, or feel. Quietness of operation is, of course, determined by sound, while the length of the tooth engagement is determined by sight. The sense of feel is utilized by applying a brake on a drum mounted on the spindle that holds the master gear, after the pinion and gear have attained a high speed. The pinion drives the master gear in this testing machine. Both the testing and burnishing machines are standard Gleason equipment.

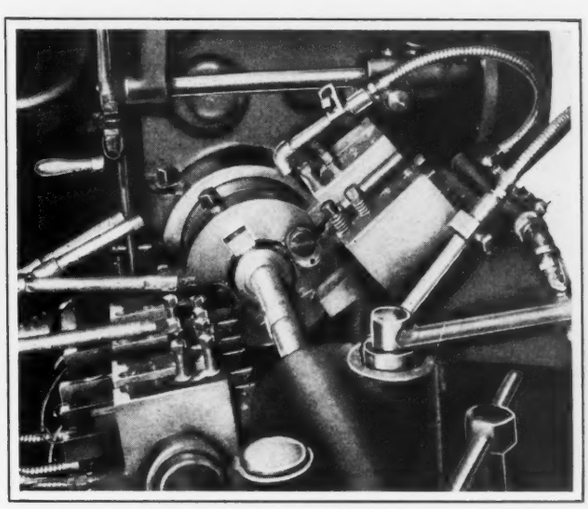


Fig. 7. Turning Rough Pinion Stems to Size in One Operation

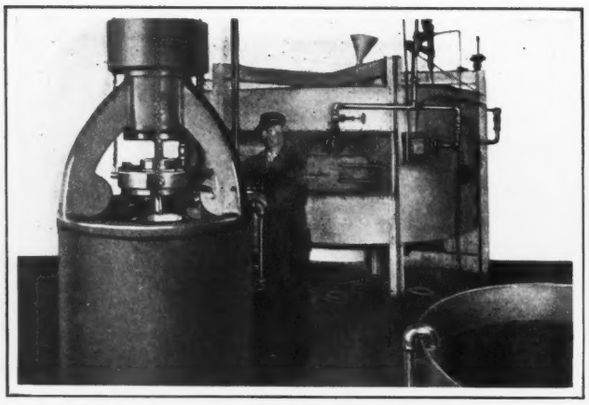


Fig. 8. Rotary Gas Hardening Furnace and Quenching Press which Prevents Warping of Ring Gears

As already mentioned, S.A.E. 2315 steel is used for both ring gears and pinions. One advantage in using a carburizing steel is that hardness can be obtained just where it is desired, and, at the same time, soft tough steel can be retained at the thin sections of the part.

During the machining process on the ring gear blanks, while a small amount of excess stock remains on the outside diameter, front counterbore, and face, the blanks are copper-plated. After the copper-plating, this excess stock is removed from the outside diameter, front counterbore, and face, and then the teeth are cut in the Gleason machines as previously described. The removal of the copper-plating from the gear teeth permits carbon to penetrate the tooth surfaces and the other surfaces mentioned, in a carburizing process.

With stem pinions, the entire stem is copper-plated, after which the bearing surfaces are "green-ground" so as to remove the copper-plating. The keyways and teeth are next cut before sending the parts to the heat-treating department. Thus, hardened teeth, keyways, and bearing surfaces can be obtained on stem pinions in the hardening process, while those sections that are to be left soft, such as the body of the pinion shaft, including the threads, are protected from being hardened.

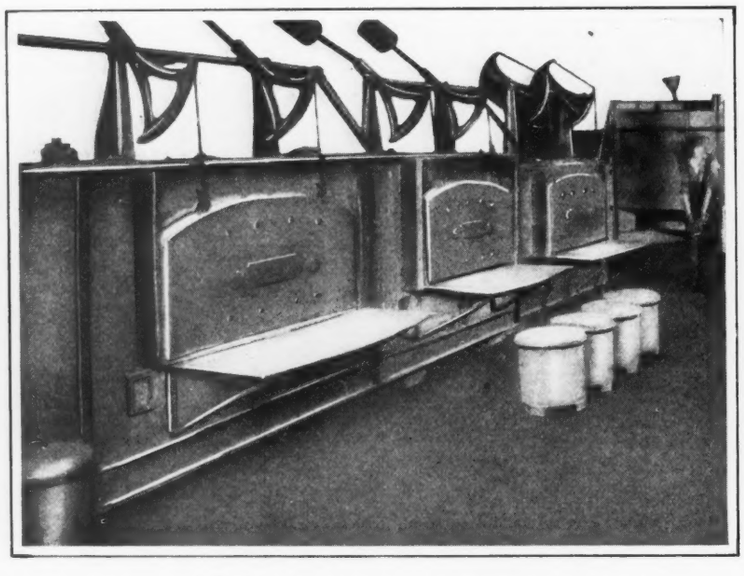


Fig. 9. General View of the Heat-treating Department, Showing the Carburizing Furnaces

For carburizing, the gears are packed in "Nichrome" pots, such as seen in Fig. 9. Two gears are always packed back to back with about 1 1/2 inches of carburizing compound between the teeth of adjacent gears. The carburizing process is conducted in box-type gas furnaces, which are maintained at a temperature of about 1625 degrees F. The parts are usually kept in the furnaces from six to nine hours after the furnace has reached the temperature mentioned, to obtain a case penetration of from 0.035 to 0.040 inch.

When the desired amount of penetration has been obtained, the parts are removed from the furnaces and the gears allowed to cool in the pots. Then the gears are run through the rotary gas furnace seen in the background in Fig. 8, which is held at a temperature of about 1460 degrees F. Each gear remains from twenty-five to fifty minutes in this furnace, depending on its size, the furnace being provided with a variable-speed motor drive so that the speed of its rotating table may be arranged to suit the work.

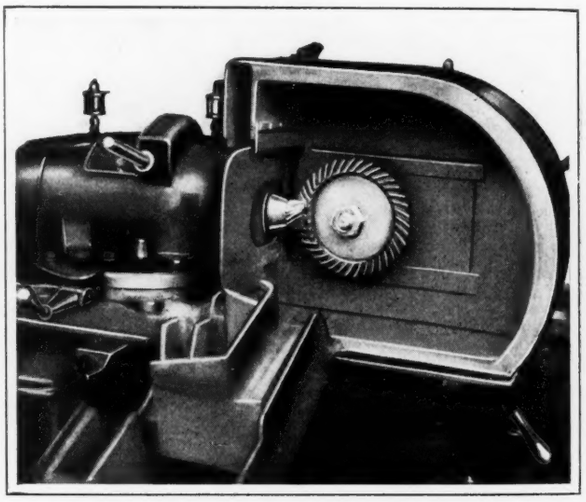


Fig. 10. Burnishing Pinion Teeth by Running Them in Mesh with a Hardened Master Gear

As the gears are taken from this rotary furnace, they are placed singly in the Gleason quenching press seen in the foreground of Fig. 8. This press is equipped with a bottom die on which the back of the gear rests while the bore is located on the die. Then, when the ram of the press descends, a top die on the ram grips the gear securely between its face and the face of the bottom die while both dies and the work are pushed into cooling oil. With this method, the gear is prevented from warping during hardening. The heat-treatment of the gears is finally completed by submerging them for about twenty-five minutes in oil heated to a temperature of from 275 to 300 degrees F.

Pinions follow a similar cycle of operations in the heat-treating department. When the pinions are removed from the rotary furnace, they are

hardened by merely quenching in oil contained in the tank seen at the right in Fig. 8. They are tempered in the same manner as the gears.

At the end of the heat-treatment, both the gears and pinions are wire-brushed and cleansed in hot cleaning compound. They are then tested for hardness either under a Rockwell hardness tester or a scleroscope, being held to a reading of between 59 and 63 on the former and between 78 and 85 on the latter.

Finish-grinding Operations on Gears and Pinions

When the ring gears leave the heat-treating department, they are delivered to an arbor press for straightening, dial indicators being employed on the back of the gears to determine their accuracy. They are then passed to the Heald "Size-Matic" grinding machine shown in Fig. 12, for grinding the bore to size within plus 0.001 inch or minus

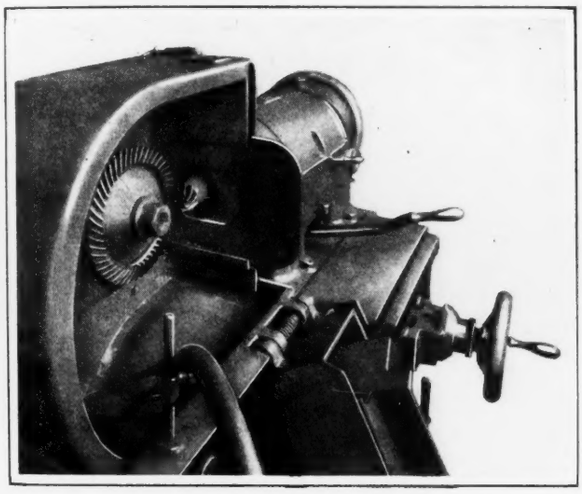


Fig. 11. Lapping Operation Performed on Mated Ring Gears and Pinions

0.000 inch. This machine is equipped with a Logan air cylinder and chuck. Three segments of the chuck grip each gear along surface *e*, Fig. 4. In this operation, the wheel makes several passes across the work and then withdraws, after which a diamond comes into position for truing the wheel. The wheel then makes several more passes across the bore of the work and finally withdraws to permit reloading, the machine stopping automatically. Opening and closing of the pneumatic chucking equipment is controlled through the valve seen at the front of the machine.

After this operation, each gear is placed on an inspection fixture similar to that shown in Fig. 3, which has an indicator that registers on the land just below the teeth along surface *e*, Fig. 4, and thus checks the concentricity of this surface relative to the ground bore. Each gear must be concentric along this surface within plus or minus 0.0025 inch.

The ring gears are next passed to the Blanchard surface grinding machine shown in Fig. 13 for grinding the back, about 0.005 inch of stock being removed. For this operation, the previously ground bore is seated on a plate at the center of the magnetic chuck. The grinding wheel is then lowered on the gear, which is rotated while only about one-

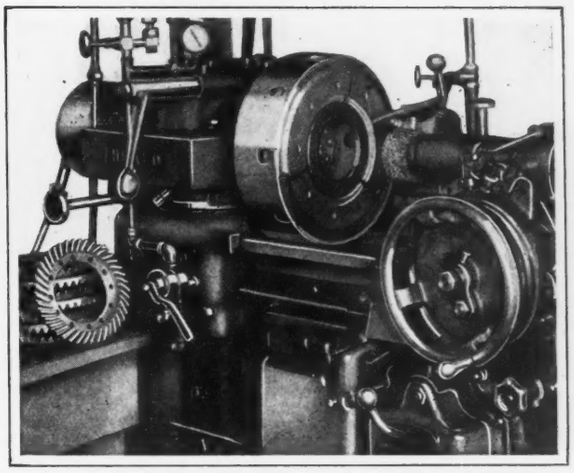


Fig. 12. Grinding the Bore of Ring Gears

half way under the wheel. This operation is performed for the sake of appearance and to facilitate final inspection. The back grinding operation, which takes place prior to cutting the ring gear teeth, as previously mentioned, is performed in an identical manner.

When the pinions leave the heat-treating department, they are taken to grinding machines, where surface *d*, Fig. 6, is finish-ground within a tolerance of 0.0005 inch, and surface *f*, within a tolerance of 0.001 inch. After the grinding, the pinions are inspected for straightness and must be true in relation to their centers, within 0.001 inch.

Lapping and Final Inspection

After the grinding operations, the ring gears and pinions are sent back to the test room and mated, each pair being judged according to appearance and quietness of operation. Their teeth are then lapped by running the mated gear and pinion together in the machine shown in Fig. 11, during which operation a mixture of oil and powdered emery dust is applied to the teeth. The gear and pinion are run both forward and backward in this

Fig. 13. Grinding the Back of Ring Gears before Cutting the Teeth and after Hardening

operation, approximately three minutes in each direction.

The lapping compound is then cleaned off and the mated gear and pinion tried out in the testing machine by running them together both forward and backward. The nature of the contact between their teeth is determined by painting red lead on the tooth surfaces and noting where the paint becomes worn off by contact as the gear and pinion are rotated. At the end of the testing, the mated gear and pinion are wired together, tagged with instructions for installation, dipped into a rust-proofing compound and sent to the stock room ready for shipment to the customer.

* * *

TOOL MANUFACTURERS' ASSOCIATION

A national association of die and tool manufacturers and of builders of special machinery has been formed under the name of the Die, Tool, Special Machinery and Manufacturers' Association, Inc., with headquarters at 40 N. Wells St., Chicago, Ill. This has been functioning as a local association in the Chicago territory for three years, and has now changed its by-laws with a view to becoming a national organization. Quoting from the by-laws, the objects of the association are "First, to promote the business interests of its members, and, second, to improve the social and industrial relationships of the members and to foster the exchange of courtesies." Committees have already been formed on standardization, statistics, publication, meetings, and papers. M. P. Heinze of the Heinze-Petzelt Machine Co., Chicago, Ill., is president; Rudolph Krasberg of the Krasberg Tool & Machine Works, Chicago, Ill., is vice-president; and Miles Irmis of the Superior Tool Works, Chicago, Ill., is treasurer. George R. Tuthill is secretary.

Manufacturers engaged in the die, tool, and special machinery field are invited to become members and to correspond with the secretary at the society's address as given above. It has long been recognized that a national association in this field would be of considerable importance to the industry, and articles that have appeared in the past in MACHINERY, written by manufacturers in this field, have emphasized the need for such an association.

* * *

An interesting fact concerning the Holland Tunnel, the vehicular tunnel under the Hudson River connecting New York City and Jersey City, is its perfect system of ventilation. The air in the tunnel is changed forty-two times an hour. Carbon monoxide gas discharged by motor vehicles passing through the tunnel is limited to less than four parts in 10,000 parts of air. The tunnel air contains less carbon monoxide than is found in many city streets.

ALLOWANCES ON USED MACHINE TOOLS

By ERNEST F. DU BRUL, General Manager, National Machine Tool Builders' Association

The General Motors Truck Co. has run an announcement in the newspapers entitled "Why There Will Be No More Excess Allowances by General Motors Trucks." Every machine tool builder and dealer should read this article, because it presents a close parallel to the machine tool industry.

The advertisement says: "There will be no more excess allowances made on used trucks traded in on General Motors trucks. By 'excess allowances' we mean allowances above the actual market resale value of the used equipment as set by fair appraisal. Some truck buyers will not agree with us that this is a sound and beneficial move. They will—mistakenly, we believe—feel that it deprives them of a benefit, but thoughtful truck buyers already agree, and even now make their truck investments on this basis. Both classes will benefit in the end.

"Money 'given' to truck buyers in excessive allowances on trade-ins has to come from some pocket or pockets. It should go, we think, into betterments that would make trucks more efficient; into engineering study and research work that would still further advance and modernize all truck transport. It should be applied to every possible improvement of methods and materials that would finally reduce all costs of commercial transportation by truck.

"But if given in unwise, unsound allowances it cannot go to these ends that would benefit all who use trucks.

"Overeagerness in selling started the practice. Competition forced others to fall in line. Many truck buyers formed the custom of considering their investments in haulage equipment as a modern sort of horse trading. The sharpest traders with plenty of time for haggling got the most for their old trucks. Trying to be shrewd sellers, they failed to be truly shrewd buyers."

Comments seem unnecessary. It is easily possible to substitute the words "machine tools" for "trucks," and "manufacturing" for "commercial transportation," and have this advertisement apply directly to the machine tool industry. It is time that this industry adopted the same policy as the eminently successful General Motors Corporation. Machine tool dealers in Chicago and Pittsburgh have already taken steps to put a similar policy into action, and dealers in other cities, as well as manufacturers, would greatly simplify the selling problems of the industry by similar action.

* * *

The population of the United States increased 45 per cent from 1899 to 1923. The use of industrial power increased 260 per cent during the same period.

Improving Multiple Tool-blocks

The means for adjusting and replacing tools in multiple tool-blocks are seldom given the consideration they deserve. The blocks and tools are frequently made to suit a particular job, and no attempt is made at standardization. Tool-blocks, however, present no difficult problems of design, and there is no reason why the details that affect the convenience of adjustment and replacement should not be worked out along consistent lines. An article in January MACHINERY, "Improvements in Multiple Tool-blocks," will deal with this important subject, which is of especial interest to tool designers and equipment engineers.

Letters on Practical Subjects

FIXTURE AND BROACH FOR FINISHING AND SLITTING CLAMPING HOLE

Formerly it was a common practice, when machining parts having holes into which slots were to be cut for clamping or adjusting purposes, to drill and ream the hole in one set-up and then saw out the opening in another operation. Recently, however, many reaming and sawing operations have been replaced by a single broaching operation, which finishes the hole and the slot in one cut. Smoother holes are obtained in this way, the tool cost per finished piece is reduced, and production increased in many instances. When the hole is finished and the slot cut in one broaching operation, a broach of the type shown at *H*, Fig. 2, is used.

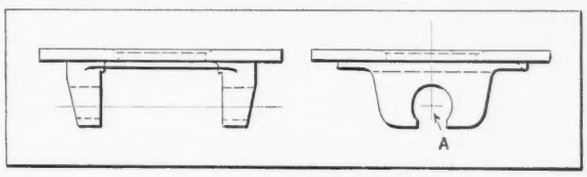


Fig. 1. Universal Joint with Cross-hole A Finished and Slit in One Broaching Operation

The cross-holes in the universal joint yoke shown in Fig. 1 are required to be held to close limits of accuracy, and must be in line with the center hole, square with the milled face of the lug, and a fixed distance from the face of the flange. When a full round broach is used, considerable trouble is experienced in keeping the holes in line, because the broach enters the hole at an angle with the face of the work. As the teeth of the broach begin cutting at the top of the hole, a downward pressure is exerted on the broach due to the angular face. It is, therefore, necessary to place the slitting teeth in front of the circular ones in order to permit the use of a guide block which will prevent the broach from being forced down or out of alignment. Another factor that tends to throw the hole out of alignment is the spring in the work caused by the heavy cut.

The fixture shown in Fig. 2 was designed to remedy the troubles referred to. The work *A* is placed in a hardened ring *B*, which is integral with the slide *C*. This slide consists of a steel block containing two spring plungers, which force the piece against a squaring strip *I* before it is clamped in

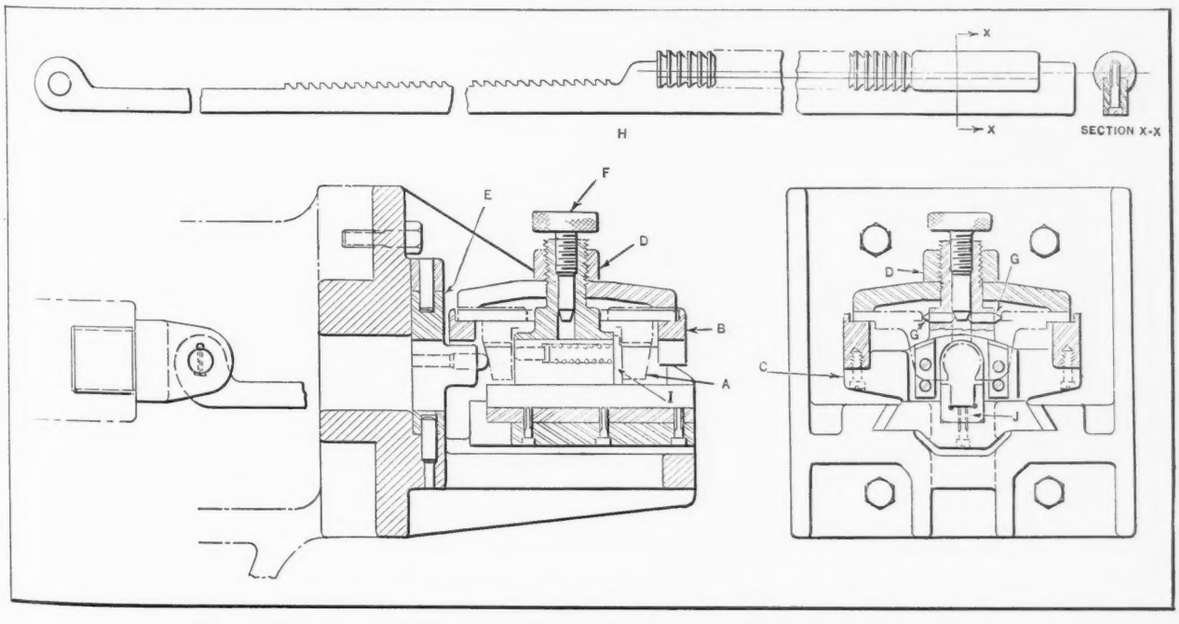


Fig. 2. Fixture and Broach Used in Finishing Hole and Cutting Slot at A, Fig. 1

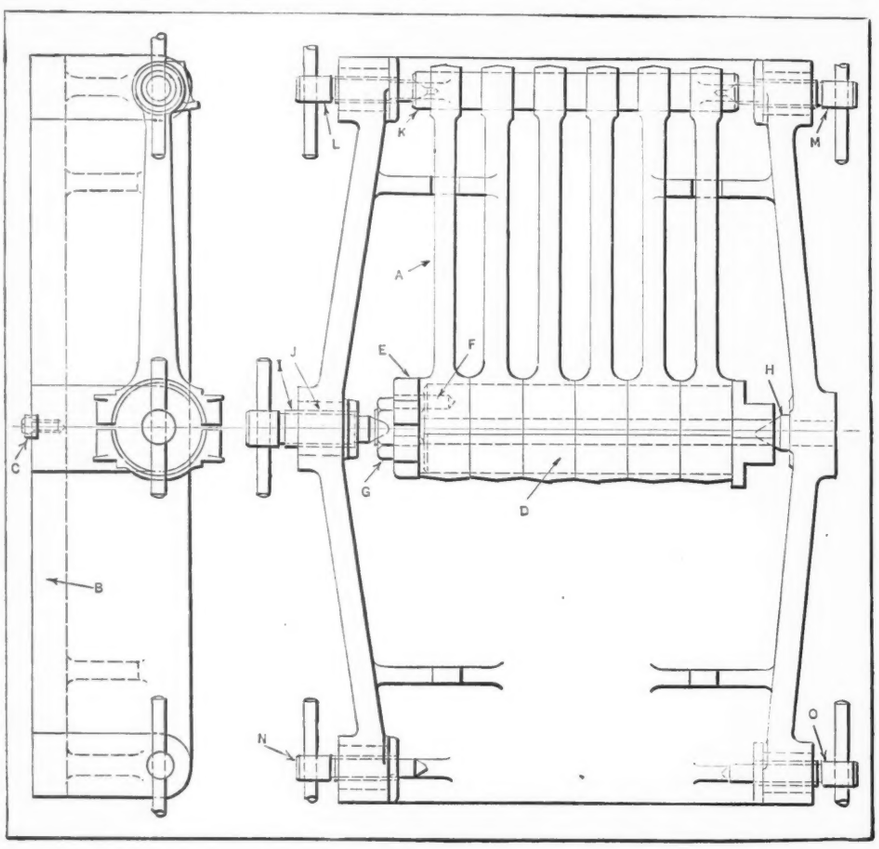
place. A hand-screw *F*, acting on two tapered rods *G*, serves to center the piece in the holder, after which it is securely clamped by means of a nut *D*.

In operation, the broach *H*, which is guided in a U-shaped block *J*, pulls the entire slide against a stationary equalizer *E*, which is provided to relieve the strain on the second lug. This equalizing member is part of the main holder, which is bolted directly to the face of the broaching machine. As only the flat section which extends beyond the end of the circular portion of the broach rests in the block *J* at the end of the stroke, the piece can be removed as soon as the hole is finished. This reduces the handling time, and also prevents the tool from marring the hole on the return stroke.

Obviously, it is impossible to give any formula for designing a broach which will suit all conditions, as the teeth must be designed to meet the individual requirements of each job. It is, however, a good rule to provide the broach with as many teeth as can be conveniently incorporated in the design, even at the sacrifice of chip clearance. A large number of teeth permits a more gradual step-up in the feed per tooth, thus decreasing the strain on the work and reducing the wear on the broach teeth. Generally speaking, the slitting teeth should take a cut from five to ten times as great as the teeth which broach the round holes. The latter teeth seldom take a cut of more than 0.010 inch on the diameter, even when used on comparatively soft material.

The rise per tooth of the broach section which cuts the slot in the part shown in Fig. 1 is 0.015 inch. The round or circular teeth increase in diameter from the first to the finishing teeth at the rate of 0.001 inch per tooth. A relatively light cut per tooth is taken by the teeth which broach the hole, in order to obtain a smooth finish, whereas a rougher finish is permissible on the sides of the slot. In some cases, however, the requirements are such that the slot must have smoothly finished sides and the hole need have only a rough finish. In such cases, the slotting teeth of the broach take a thinner cut per tooth than the teeth which finish the round hole.

South Plainfield, N. J. H. C. KLINE



Fixture for Holding Connecting-rods when Slotting the Caps and Milling the Bolt-head Seats

SLOTTING AND MILLING FIXTURE FOR CONNECTING-RODS

The design of a milling fixture for use in slotting the caps and milling the bolt seats of connecting-rods is shown in the accompanying illustration. Six connecting-rods *A* are clamped in the fixture at one time. The bearing holes are broached and the wrist-pin holes reamed previous to the slotting and milling operations.

The base *B* is located on the milling machine table by means of keys *C* at each end of the fixture. The arbor *D* is a close sliding fit in the broached holes in the large ends of the connecting-rods. A washer *E* holds the rods on the arbor, and this washer is located and held in place by a pin *F*, which fits a reamed hole in the end of arbor *D*. The nut *G* serves to clamp the washer securely against the face of the connecting-rod at the left-hand end of the arbor.

The main arbor *D* is located between a fixed center *H* and an adjustable center *I*, which is threaded to fit the bushing *J*. The small arbor *K* is held between two adjustable centers *L* and *M*, which are also threaded to fit bushings in the frame of the fixture. After the slotting and milling operations have been completed on one side of the connecting-rods, the centers *L* and *M* are loosened so that the arbor *K* can be swung over to the opposite side of the fixture, where it is secured by the adjustable centers *N* and *O*.

Rochester, N. Y. EDWARD T. HEARD

ENGINE PISTON GRINDING FIXTURE

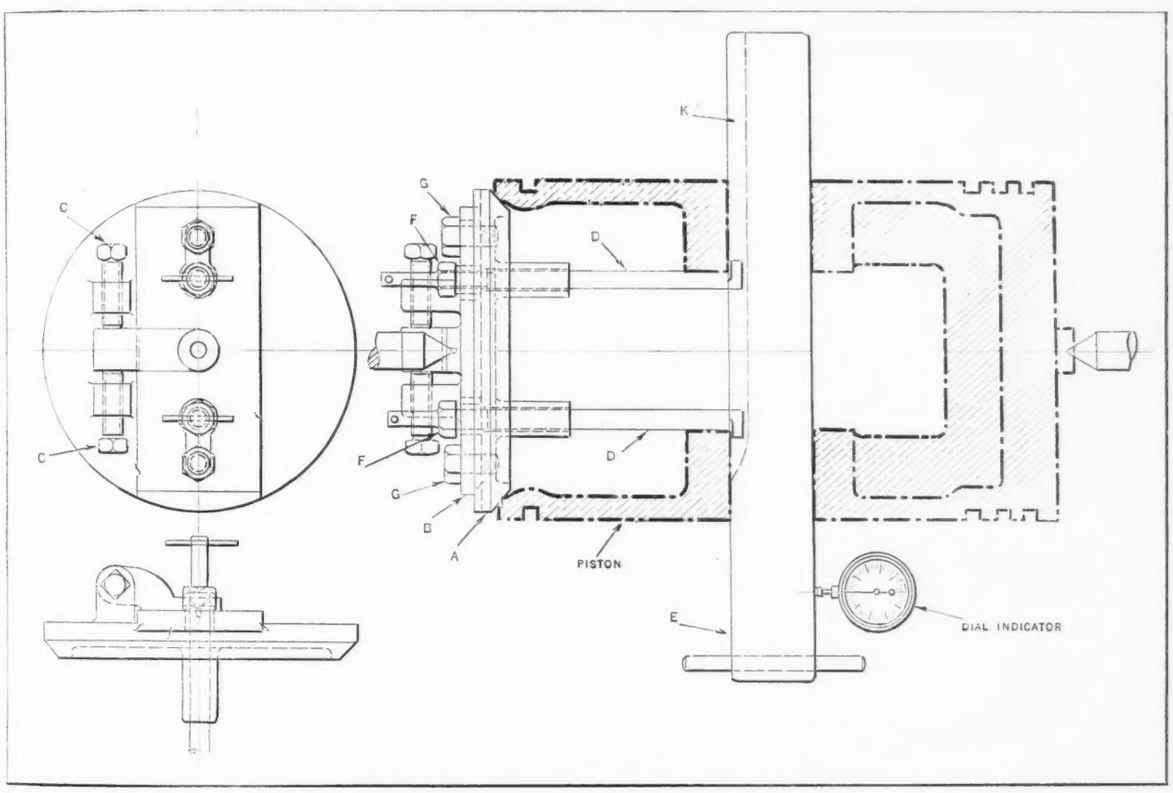
To insure the best working conditions for Diesel engine pistons of the type shown in the accompanying illustration, the wrist-pin hole must be at right angles to the axis of the piston within close limits

of accuracy. The fixture illustrated is designed to maintain the required degree of accuracy when grinding the outside of the piston. Part *A* is finished to suit the bevel in the skirt of the piston. The sliding member *B*, which is provided with a center to receive the supporting center of the grinding machine, can be adjusted by means of the setscrews *C*, to locate the test bar *E* at right angles with the axial center line which passes through the work-supporting centers of the grinding machine. The hook-bolts *D* serve to hold part *A* firmly against the bevel in the skirt of the piston while the required adjustments are being made.

When the piston is in position, the hook-bolts are swung into the wrist-pin hole. Arbor *E* is then inserted, as shown in the illustration. The keyway *K* provides clearance for the hook-bolts and prevents them from turning when clamping the fixture to the piston by means of the special hexagonal nuts *F*. After the fixture and piston have been mounted on the grinding machine centers, the dial indicator is used to determine if the piston is accurately lined up for grinding the cylinder at right angles with the wrist-pin hole. By turning the piston one-half revolution on the machine centers and testing the position of the bar with the indicator, any error in adjustment will be detected. The error can then be corrected by adjusting slide *B* with setscrews *C*. If properly adjusted, the indicator will show the same reading at both ends of arbor *E*.

Bolts *G* hold the part *B* firmly against member *A*. Arbor *E* is removed after the alignment has been correctly checked and the piston ground to size. No trouble from scored cylinders has ever been experienced with engines fitted with pistons which were lined up and ground as described.

Worcester, Mass. C. W. PUTNAM



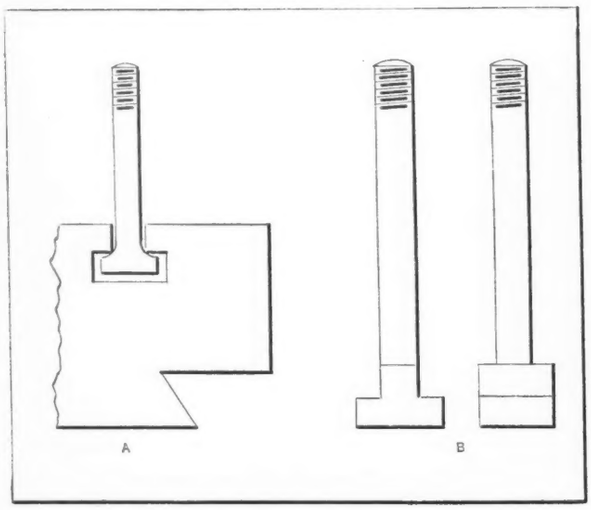
Fixture for Aligning and Grinding Diesel Engine Piston

DEFECTIVE CLAMPING BOLTS DAMAGE MACHINE TABLES

The importance of providing properly designed and accurately machined T-bolts for securing the work to machine tables is overlooked in many shops. Defective bolts have a detrimental effect on the work turned out and are likely to affect the accuracy of the machine table. Table bolts of correct design, accurately machined to fit standard slots, should be provided for all machines. The machines should, of course, have standard size slots. The maximum side clearance for bolts in machine table slots should not be over 1/16 inch. Bolts 5/8 inch in diameter should not be used in 3/4-inch slots, nor should 3/4-inch bolts be used in 7/8-inch slots.

In a plant operating a large battery of milling machines of different sizes, a common complaint of the operators was that they had great difficulty in holding certain work within the specified limits. The cause of the trouble was quickly determined on making a careful examination of the machine tables. Every table from the smallest to the largest was found to be warped. In some cases, a straightedge placed on the table lengthwise showed the surface to be from 0.015 to 0.059 inch lower at the ends than at the middle. An order was immediately given to have the top and bottom of every table planed up and refitted. The battery of machines referred to had been operating under heavy production schedules for nearly seven years. It was found that table clamping bolts having poorly designed heads were mainly responsible for the inaccuracy of the machine tables.

Hundreds of the bolts examined had been ground down on their shanks to permit them to enter the slots in the milling machine tables. The under sides of the heads of these bolts had large radius bear-



(A) T-head Hold-down Bolt with Radius Bearing under Head, which Causes Table to Warp; (B) Correct Type of T-head Bolt for Holding Work on Machine Tables

ing surfaces, such as shown at *A* in the accompanying illustration, which resulted from using grinding wheels having rounded edges. The radius bearing surfaces of such bolts obviously exerted pressure on the edges of the slots. This severe concentration of pressure on the small contact surface of the tables resulted in a peening action on the under side of the table slots, which caused the tables to become warped.

It may seem superfluous to add here that all such bolts should be thrown on the scrap heap along with the old round-head bolts often used for clamping purposes, and that new accurately machined bolts of proper design should be provided. In the writer's opinion, the only practical type of bolt and the only one that should be used for holding work on slotting, shaping, milling, and planing machine tables is that having a T-shaped machined head, such as shown at *B* in the illustration.

Allston, Mass. FRANK RATTEK

DEVICE FOR DRESSING RADIUS FORMING GRINDING WHEEL

A device for dressing the grinding wheel used in forming an annular bearing on the shaft *S*, Fig. 1, to a true radius *X* is shown in Fig. 2. The shaft *S* is not produced in large quantities, but sufficient numbers are manufactured to warrant the cost of constructing the dressing fixture. The shaft, which is of nickel steel, is roughed out on a turret lathe, heat-treated, and ground to the finished dimensions. Two machines are used in grinding the piece, one for grinding the straight portions and one for the plunge cut which forms the radius surface *X*, Fig. 1. For the latter operation, it is necessary to dress the formed wheel at frequent intervals, using the device shown in Fig. 2.

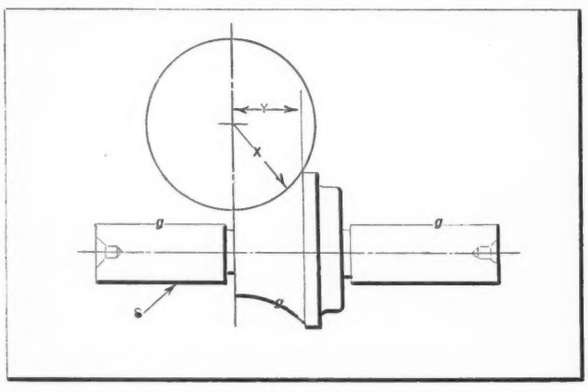


Fig. 1. Nickel Steel Shaft to be Ground

The frame *A* of the truing device is bolted permanently in place on the table of a Brown & Sharpe grinding machine by hook-bolts *B*. This frame is designed to allow sufficient room for the work to swing on the centers of the machine when performing the grinding operation. The wheel is dressed by swinging the cast-iron bracket *C* on its two centering bushings *D*, which are supported by two hardened points *E* and *F* in frame *A*.

The upper point *F* has a shank *G* which is pinned to the cam *H*. This cam serves to raise the center against the pressure of spring *L* when the operator turns the handle *K*. The swinging bracket *C* can thus be readily removed or put in place without interference from the center points.

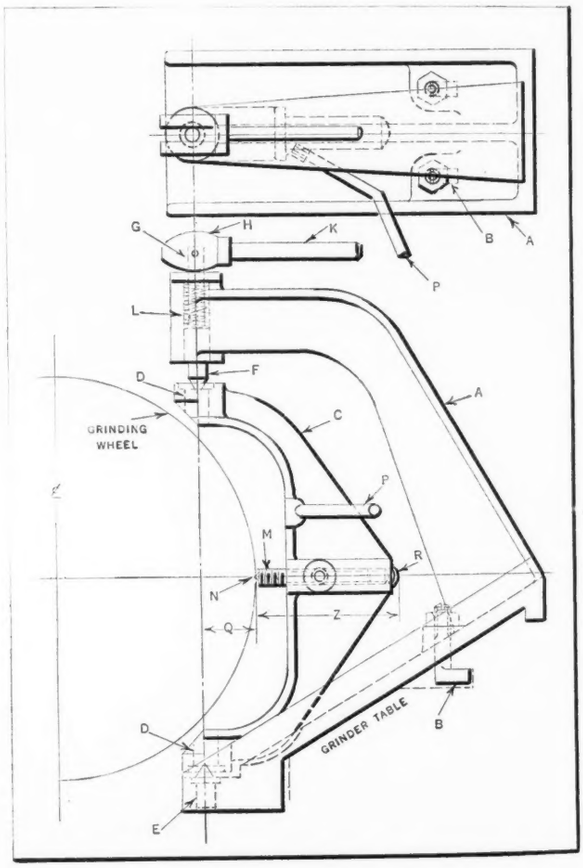


Fig. 2. Fixture for Dressing Wheel Used in Grinding Radius on Part Shown in Fig. 1

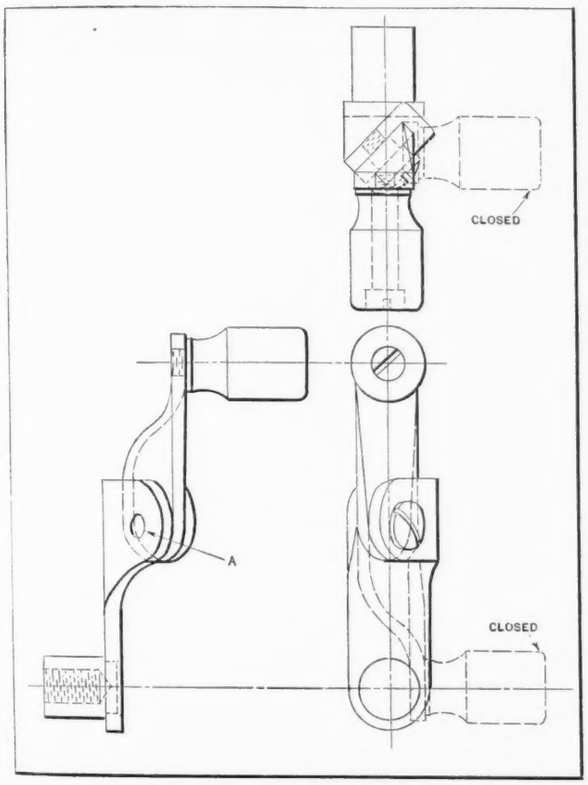
A stud *M* is located in the swinging member *C*, in line with the center of the grinding wheel spindle, and in the end of the stud is set a dressing diamond *N*. The point of the dressing diamond will true the grinding wheel to the required radius *Q* when bracket *C* is swung on its centers by means of handle *P*. The distance from the point of the truing diamond to the vertical center line passing through the bearing points *E* and *F* can be adjusted by screwing the stud *M* in or out as required.

The distance or radius Q can be determined by measuring the distance Z with a micrometer. As the distance from the point R to the vertical center line is known, the dimension Q is obtained by subtracting the micrometer measurement Z from this distance. After the wheel is dressed, the upper center F is raised, the frame C removed, and the work placed between the centers. The plunge cut required to finish the work shown in Fig. 1 to the required radius X is then taken. A stud stop determines the depth of the plunge cut, and the table of the machine is locked against longitudinal movement.

New York City — B. J. STERN

FOLDING CRANK FOR PORTABLE DEVICES

A folding crank for use on various types of portable apparatus is shown in the accompanying illustration. It will be obvious that if this crank is



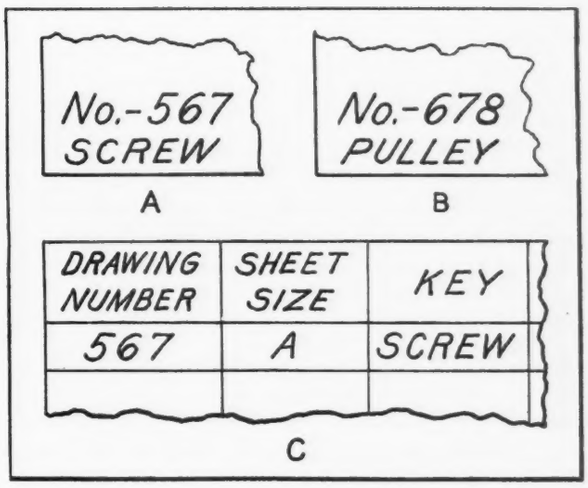
Folding Crank for Portable Apparatus

folded at the hinge A, the outer end, in folding back through an angle of 180 degrees, will also be twisted through an angle of 90 degrees and will lie in the position shown by the dotted lines.

Rochester, N. Y. — ERNEST C. ALLEN

SIMPLE DRAWING RECORD SYSTEM

It has been the writer's experience that there is much needless duplication of designs and details in the average drafting-room. This is partly due to the fact that very few drafting-rooms have a system of filing drawings or of keeping records which permits the designer or draftsman to determine quickly if any previous design can be made to serve the needs. A simple method of filing all drawings of a kind in separate drawers or compartments, as



Method of Using Key Words on Drawing and Index Cards when Drawings for All Parts of One Kind are Kept Together

described here, will do much to overcome this drawback, and will prevent much unnecessary work in the drafting-room.

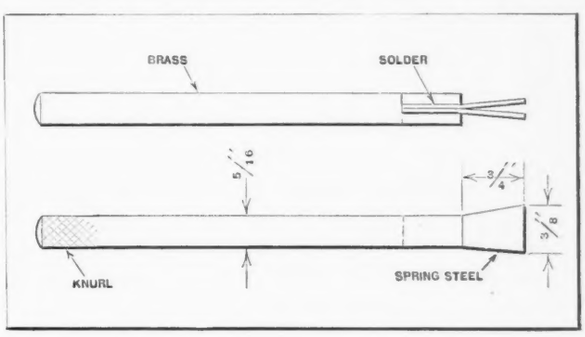
By filing all drawings of screws together, for instance, it is an easy matter to look over all the detail drawings of screws without disturbing drawings of other parts. This also applies to drawings of all other details or parts of one kind. In using this system, the draftsman simply letters in the key word under the drawing number, as shown at A and B in the accompanying illustration. These drawings are then filed in the compartments set aside for drawings of screws and pulleys, respectively.

The key word, the size of the drawing sheet, and the drawing number are placed on the index cards, which give the history of the part. The brief description given here merely outlines the fundamental idea on which the system is based. By properly subdividing the classes of parts or details, the system can be expanded to meet the requirements of practically any drafting-room.

Worcester, Mass. — J. C. P. BODE

SCREWDRIVER FOR INACCESSIBLE PLACES

The writer has used a set of three screwdrivers of the design shown in the accompanying illustration for a number of years. The smallest size screwdriver has steel blades 1/8 inch wide, which project 1/2 inch from the holder. The next or intermediate size has blades 1/4 inch wide which



Screwdriver with Double Blade for Holding Screw

project 5/8 inch. A set of screwdrivers of this kind will be a welcome addition to any mechanic's tool box, and is especially useful for such work as assembling radio sets.

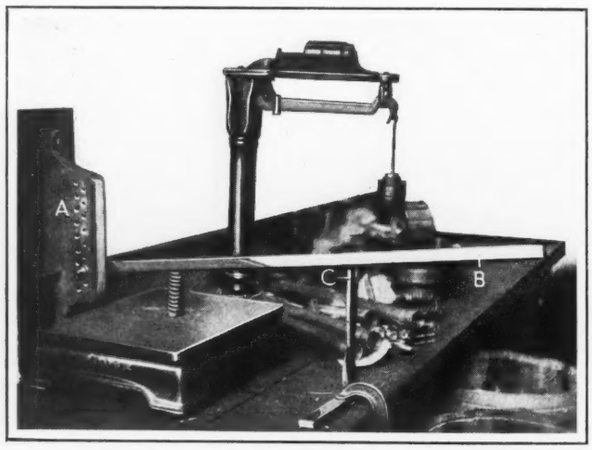
The construction is very simple. A piece of brass of any suitable diameter and length is knurled, if preferred, and then slotted to a depth of 1/2 inch at one end with a hacksaw. Two pieces of hardened and tempered spring steel are then cut 1 inch long. These pieces are curved slightly, placed back to back, in the saw slot in the brass rod, and soldered in place. For the small screwdriver, the writer used spring steel 0.010 inch thick, 1/8 inch wide, and 1 inch long. For the medium sized screwdriver, two pieces of spring steel 0.015 inch thick, 1/4 inch wide, and 1 1/8 inches long were used; and for the large screwdriver, two pieces of spring steel 0.020 inch thick, 3/8 inch wide, and 1 1/4 inches long.

In using the screwdriver, the two pieces of spring steel are compressed between the forefinger and thumb and inserted in the slot in the head of the screw. The screw is then driven into place in the regular manner. If necessary, a regular screwdriver can then be used to drive the screw down tight. W. H. B.

[A suggestion for a screwdriver of somewhat similar design has also been received from John J. Marshall, San Francisco, Calif. Mr. Marshall mentions that he made several such screwdrivers thirty-five years ago, three of which are still in his possession.—EDITOR]

DEVICE FOR TESTING SPRINGS

In the making of experimental machines, special springs are often required. When a number of springs are to be made up in sets, springs of the same strength can be assured by testing them in the manner shown in the illustration. This method gives quite accurate results. A wooden block *A* with holes drilled in it, for setting the fulcrum end of the lever *B* at different heights, is bolted to the back of the bench. The lever used in this instance is of 3/8- by 1 1/4-inch iron. A slotted stop *C* insures that the lever is pressed down the same distance each time. Each spring of a set must be placed in the same spot on the scale platform.



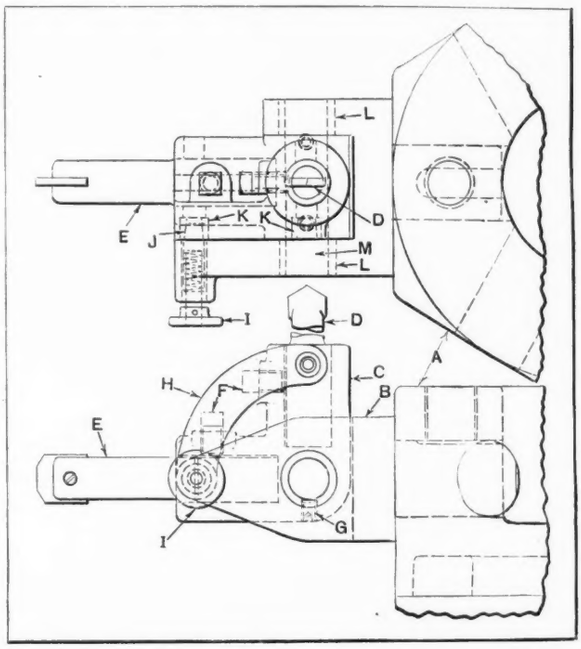
Arrangement of Beam Scale for Checking Uniformity of Springs

In operation, the lever is pressed down to the bottom of the slot in the stop *C*, compressing the spring, and the scale beam indicates the "weight" of the spring. If this spring is taken as a standard, then the other springs of the set must "weigh" the same within allowable limits.

La Grange, Ill. AVERY E. GRANVILLE

AUXILIARY STATION FOR TURRET LATHE

When small lots are being machined on a turret lathe, it is often desirable to have an extra turret station. The swivel-holder shown in the accompanying illustration was designed to meet such needs. The holder *B* is fastened securely in one of the station holes in the turret *A*. The swivel *C* swings with the shaft *M* in the hardened steel bushings *L*, which, in turn, are a drive fit in the holder *B*. The standard boring-bar *E* and core-drill *D* are located at right angles with each other, and are held securely by set-screws *F*.



Two-tool Attachment or Holder for Turret Lathe

The indexing for the two positions of the tools is accomplished by means of the spring-actuated plunger *J*, which slides into the tapered holes of either of the two bushings *K*. It will be noted that the face of the segment *H*, cast on the swivel *C*, makes contact with the face of the bushings *K*. This provides for uninterrupted engagement of the plunger with the bushings. The screws *G* prevent any turning action of the shaft in member *C*.

Bridgeport, Conn. J. E. FENNO

* * *

According to Clarence A. O'Brien, patent attorney, many useless patents are applied for through the United States Patent Office. Among the highly useless ones that have recently been applied for are a mechanical hat tipper, a sloping trestle arrangement to enable railroad trains to pass over one another on the same track, and a bed that falls apart when the alarm clock goes off.

What MACHINERY'S Readers Think

Brief Contributions of General Interest in the Mechanical Field

THE EFFICIENCY ENGINEER'S SERVICE

The efficiency engineer can be of great value to any plant. He presents an outside point of view on shop problems. Often he is able, because of his knowledge and experience, to point out wrong conditions and to aid in their elimination. But engineers who promise short-cuts to profits through panaceas show that their knowledge of management and shop practice is as shallow as their vision is narrow. The efficiency engineer should have knowledge on which to base his efforts, and personal experience to qualify him for his work.

Broad concepts are necessary for success. Sufficient attention should also be paid to the worker's point of view, and there should be cooperation with the regular organization. A good efficiency engineer can be of great benefit in producing a high degree of production efficiency by discovering waste and installing the proper manufacturing operations or processes. A. GORDON

LEARNING SOMETHING NEW ABOUT SPEEDS

There is a general tendency to under-speed a machine tool rather than over-speed it, because we know, or think we know, the limits that the cutting steel and the machine will stand. In a department where all the machines were engaged in the same work, the spindle speeds had been gradually increased, as improved cutting steels became available, until all cutters were running at a speed of 210 revolutions per minute. Soon after this speed was adopted, some stellite cutters were purchased. Two machines were equipped with cutters of this material and speeded up to 290 revolutions per minute. It was considered advisable to leave the other machines as they were for a time, meanwhile using the stellite cutters on the two machines that had been speeded up.

Through some oversight, the stellite cutters were worn out before new ones were ordered. While the machines were idle, an operator who knew less about speeds and cutting steels than his fellow operators, took it upon himself to help out during the rush by putting the ordinary high-speed cutters on the two high-speed machines. The speed for which these cutters were intended was 210 revolutions per minute, and even this speed was slightly higher than the generally accepted rate for high-speed steel on the class of work being handled. However, the cutters proved to be fully capable of standing up at a speed of 290 revolutions per minute, and that speed has since been set as a new limit.

In modern woodworking shops, a surface speed of 15,000 feet per minute is an accepted reality for circular saws running on modern machines, whereas 8000 feet per minute was considered the limit but a few years ago. At a recent section meeting of the American Society of Mechanical Engineers, a German guest told about the new practice in Germany, where they are successfully running the same type of saws at speeds of 25,000 feet per minute or more, this being made possible by employing air-blast cooling installed underneath the saw table. DONALD A. HAMPSON

A STANDARD TAPER IS REQUIRED

The adoption of a standard taper shank would be of value to all concerned. It would reduce the number of taper gages, and small tools could be interchanged in all machine tools. Lathe taper attachments could be graduated so as to be positively adjusted to the standard taper adopted.

Any standard that is adopted should be proportioned correctly to hold securely. It should be easily tabulated and should not be too radical a change from the present standards now in use. The nearest standard to meet these requirements, in my opinion, is the Jarno taper.

CARL E. SCHINMAN

REDUCING COSTS ON NEW MODELS

The idea of cooperation between the engineering staff and the shop on new models, brought out in the article on page 24 of September MACHINERY, is an excellent one. On certain phases of new design work, there is a method of approach that is even cheaper and more positive than the unchecked drawing that was suggested in the article referred to. In the case of involved mechanisms or where there is a question of clearances, a simple wooden model will often give a quicker, cheaper, and more accurate answer than any paper lay-out ever could.

By simply hooking up a series of wooden parts, made to conform to the theoretically desirable essential dimensions, the functioning of the motion of a new model can be studied. It is much easier to work out the difficulties in these wooden parts than to wait until forgings, machined parts, and fixed length rods are designed and manufactured. When the essential feature is established, details may be made up with assurance of success.

When clearances are involved, a main structure or machine may be made from wood and paper. Wooden dummies, or actual parts if available, may be fitted to develop the clearances and the most convenient locations. The time so spent will be a good insurance against assembly griefs.

When lines for shape are involved, as in the case of a boat or airplane, only typical construction details should be prepared in the drafting-room, and the lines lifted from the mold loft in the form of a templet. Working to a full-size scale on the mold floor insures better curves and simplifies the drafting work. CHARLES E. KIRKBRIDE, JR.

Gear Tooth Breakage, Wear and Noise*

By A. B. COX, Consulting Engineer, Wilkinsburg, Pa.

THE three essential requirements of gearing are: (1) Strength to transmit the desired load under any and all reasonably possible conditions; (2) ability to resist wear sufficiently to have an economic life; (3) reasonable quietness for the type of mechanism to which the gears are applied.

The usual ways of obtaining great tooth strength are to make the teeth as short as possible; to make the pressure angle as great as possible, for a tooth that is wide at the base; and to use good material and as coarse a pitch and wide a face as are consistent with requirements of space, weight, and cost. On account of the inflexibility of such teeth, the highest accuracy of tooth contour and spacing that are economically attainable must be striven for to minimize impact stresses. These methods have been pushed to their utmost practicable limits in such tooth systems as the Maag. In such designs there never is continuously more than one pair of teeth in contact to carry the load.

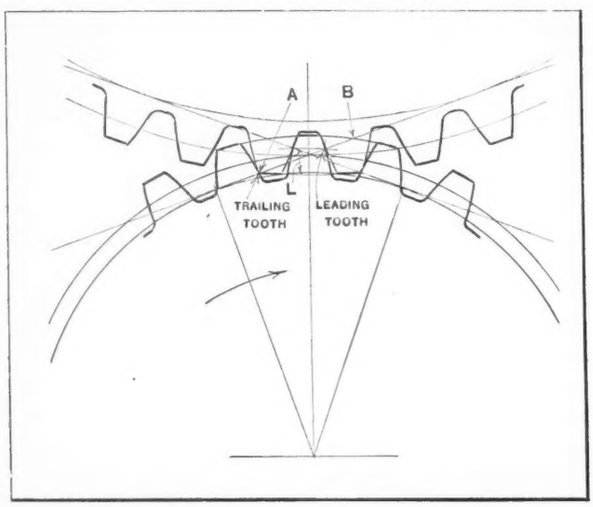


Fig. 1. Tooth Contact in Stub-tooth Gears. Driver, 25 Teeth; Driven, 47 Teeth; Pitch, 7; Pressure Angle, 20 Degrees; Contact Distance AB, 1.36 Pitches

In such single-tooth-contact designs, care must be taken to provide sufficient tooth-contact overlap so that, even when the gear and pinion-shaft bearings are worn and the shafts are deflected under load, both to the greatest permissible extent, and when all the manufacturing tolerances combine to reduce the duration of tooth contact, still the leading tooth in the zone of contact shall not leave contact before the next following, or trailing, tooth makes contact. This means that the average calculated number of teeth in contact should be not less than about 1.4. This number is equal to the length of the line of action included between the outside diameters of the meshing gears *AB*, in Fig. 1, divided by the normal, or base-circle pitch. In extreme cases a number slightly smaller than 1.4 can be used, but safe tooth-overlap is jeopardized.

The single-tooth-contact gear set is not the strongest possible design, but the strength of the individual teeth can be made the greatest possible for this type of design by using as large a pressure angle and as large a fillet at the root of the tooth as possible without interfering with the teeth of the meshing gear.

Load on One Tooth of Single-tooth-contact Gears

The safe strength of all single-tooth-contact gears must, of course, be calculated for the position of mesh that is of least strength. This position, in perfectly accurate gearing, is that shown in Fig. 1, in which the trailing tooth has not quite come into contact and the leading tooth is carrying all the load. The total dependable strength of such gears is, therefore, the strength of this leading tooth alone, with the total gear load applied at the distance *L* from the root of the tooth. When the trailing tooth comes into contact and shares the load with the leading tooth, the total strength of the gears is the combined strength of the two pairs of teeth. But, since this second tooth is not always in contact, its strength cannot be added to that of the leading tooth for either steady-load strength or shock-load strength. Also, on account of the great stiffness of these short teeth, there is very little deflection under load; hence, errors in tooth contour and in tooth spacing cannot be compensated for by the deflection of the teeth; and, unless the gears are extremely accurate, such gears require the use of a very high velocity-correction in the strength calculations. Because of the greater elas-

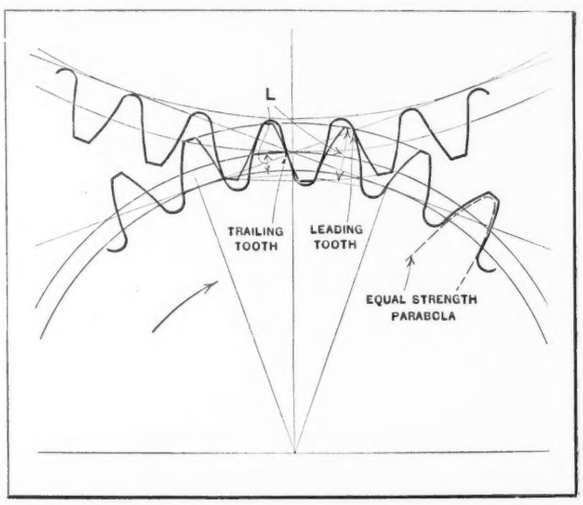


Fig. 2. Integral-contact Gears. These Gears Have the Same Specifications as Those in Fig. 1, Except that the Contact Distance is 2 Pitches

*Abstract of a paper presented at the Production Meeting of the Society of Automotive Engineers in Detroit, November 22 and 23.

ticity of the integral-contact gears described later, a smaller velocity-correction can be used than for short-tooth gears. On account of the inflexibility of single-contact teeth, a comparatively small error is sufficient to hold the trailing tooth out of mesh and cause all the load to be carried by a single tooth through the entire length of the contact zone. Standard full-depth teeth exactly similar to the standard stub teeth of Fig. 1, except for the tooth depth and size of root fillet, are very little stronger than those of Fig. 1 if both sets are assumed to be accurately made and mounted, and they are very much weaker if sufficient inaccuracy exists in the gears to cause the load to be carried on only one pair of teeth at the end of the contact zone.

"Integral-contact" Gears Designed so that Two Pairs of Teeth are Always in Contact

Fig. 2 shows a set of gears designed so that they will always have two pairs of teeth in contact, no matter what the relative positions of the gears may be during rotation. Assuming that the gear teeth are accurately formed and spaced so that the total-load pressure transmitted by the gears is shared by the two pairs of contacting teeth, it is easy to see that the weakest position of these gears is that shown in Fig. 2. In this position, the leading pinion tooth is just on the point of dropping its load. On account of the relatively greater deflection of the leading tooth, it carries less than half the transmitted-load pressure, although there are factors that tend to make up for this condition. The tooth is loaded as a cantilever, with the force applied at the greatest possible distance from the root. The trailing tooth is carrying the greater load-pressure, but, since the force is acting on it at a point much closer to the root than is the case on the leading tooth, this tooth is less likely to break than the leading tooth. The minimum total steady-load strength of these gears is, therefore, the sum of the strengths of the leading and the trailing teeth, and is greater than that of the design shown in Fig. 1.

Compared with other modern gearing of the best designs, integral-contact gearing has shown itself to have the following qualities: Much greater strength, both for steady load and for shock load; much longer life; or smaller dimensions, cheaper materials, or cheaper manufacturing processes for the same strength and length of life; a greater degree of both initial quietness and enduring quietness.

This type of gearing should be particularly suitable for automobile transmissions and timing gears, and for replacing spiral-bevel drive-gears with straight-bevel gears. On account of the characteristic action of bevel gears, smaller numbers of teeth can be used for integral contact than is possible in parallel-shaft gears. The minimum number for spur gear pinions is about 16, and for bevel pinions, about 13. The improvement secured by the use of integral-contact gears is not limited to one design feature or to features of minor importance, but extends to all three of the major essentials of gearing. Virtually the only objection of any importance that can be made to the use of these gears is that their design requires greater engineering skill than is usually employed in the design of ordinary gears.

Gears of this type carried a load of 1680 pounds per inch of face width at a speed of 1500 revolutions per minute. Calculating the static stress in these teeth on the basis of exactly equal division of load between the two pairs of contacting teeth, a value of 125,000 pounds per square inch is obtained. At last report the gears had run 10 hours per day for 3 1/2 months and were running even better than at first. Since gear teeth seldom break under steady load but nearly always under shock load, the high shock load strength of integral-contact gears makes it possible to design such gears with a very low factor of safety for steady load. This increases the total load-carrying capacity of integral-contact gears still further beyond that of other gears.

Width of Tooth at End

At first sight the pointed tooth (see Fig. 2) looks weak, but the inscribed equal-strength parabola shows that it is as strong at the tip as at the root; that is, the teeth are substantially constant-strength cantilevers, and the "flat" at the end of the tooth makes no difference in the strength. Ordinarily this flat can be made approximately equal to the greatest backlash allowable when the gears are old and the teeth fully worn. In many cases this maximum permissible backlash is not very large, and the tooth flat is made much larger than is necessary, as shown in Fig. 1. Most gears would be renewed on account of excessive backlash long before the tip of the tooth had worn down to a knife-edge. An unnecessarily broad-ended tooth means an unnecessary sacrifice of tooth strength.

When Errors in Form or Spacing Occur

Supposing that, in these two-tooth-contact gears, because of errors in tooth contour and tooth spacing, the trailing pair of teeth does not make contact in time to help in carrying the load as intended by the designer, three things tend to relieve the condition:

1. Under any practically permissible error of modern commercial gearing, the leading tooth will deflect sufficiently to overcome the effect of the error and cause the trailing tooth to come into contact long before a breaking stress in the leading tooth is reached.

2. If the load on the leading tooth is further increased up to the breaking point, the trailing tooth will take up an increasingly greater proportion of the total gear-load as the leading tooth deflects, on account of its much smaller deflection. This condition of approximate stress equalization always exists when the load occurs in peaks, or as shock loads; it exists for steady loads only when the gears are new or comparatively unworn.

3. Wear of gear-tooth contours is due primarily to tooth pressure, and if there are errors of either tooth contour or tooth spacing which tend to make any pair of teeth carry more than their share of the load, these teeth will wear down more rapidly than the more lightly loaded pairs of teeth. This wear tends to cause equal division of the total-load pressure among the pairs of teeth in contact.

From every viewpoint, therefore, whether the gears are new or worn, it is safe to assume equal division of load between the pairs of contacting teeth as a basis for calculating the total minimum steady-load static strength of these gears. Such gears, having always two pairs of teeth in contact, have been given the name of integral-contact gears.

Integral-contact Gears Wear so as to Correct Tooth Form

It is a matter of actual observation that integral-contact-gear teeth tend to wear so as automatically to correct the tooth form, and that other gears tend to wear out of shape. For peak loads and shock loads that occur so seldom as not to affect the tooth contour appreciably by wear, the leading tooth of integral-contact gearing deflects and allows the trailing tooth to carry much more than its proportionate share of the load. Since the point of application of the load on the trailing tooth is so near the root, this tooth has the strength of a stub tooth, and the total shock-load strength of the gears is approximately twice that of their steady-load strength. Single-contact gears have no reserve strength to resist shock loads. For the same length of life, integral-contact gears are able to carry much greater loads than other gears, or they can be made with narrower face or of cheaper materials or given cheaper heat-treatment. By combining gear-tooth-strength formulas with wear formulas, it can be shown that, to have somewhere nearly the same factor of safety against wear as against breakage, much finer pitches than are now customary should be used for a given load.

* * *

THE BRITISH METAL-WORKING INDUSTRIES

From MACHINERY'S Special Correspondent

November 15, 1928

Although the continued increase in the number of unemployed persons in this country is causing anxiety, conditions in most branches of the metal-working industries have shown considerable improvement during recent weeks, and it may be argued that as these industries get into their stride again, the beginning of the process of reabsorption of labor cannot long be delayed. The machine tool industry remains well employed, disproportionately so when the state of the consuming industries is taken into consideration. There has been no appreciable increase in machine tool exports, while imports are well maintained, so that it is evident that there is a strong demand for machine tools in the home market. Manufacturers are thus clearly realizing that competition is only to be met successfully by improved manufacturing methods, and it would appear not unlikely that the installation of modern equipment is having a temporary adverse effect on the unemployment situation.

The Automobile Industry

Since the last monthly report was written the Motor Show has been held at Olympia, and it is now possible briefly to review the main directions of progress in the design of cars destined for the British market. Turning first to engines, we find that the six-cylinder unit is now definitely in the ascendency, this type accounting for 49.6 per cent of the total, followed by four-cylinder and eight-cylinder units with 34.6 and 14.6 per cent, respectively. Overhead valves are becoming increasingly popular, 48.1 per cent of engines now being equipped with this type, as compared with 46.5 per cent in 1927.

The most striking change since last year is perhaps to be found in the ignition systems, where the coil is now seriously challenging the supremacy of the magneto. In 1926, 23.1 per cent of cars were fitted with coil ignition; in 1927, the percentage had increased to 29.8, and today it is 45.4 per cent.

For the important duty of chassis suspension the half-elliptic spring remains by far the most common type. No less than 92.2 per cent of cars have front springs of this type, while the percentage in the case of rear springs is 72.2, quarter-elliptic and cantilever each claiming 11.8 per cent.

Four-wheel brakes are now standardized on every car. As was only to be expected, business in the automobile industry was comparatively slow during the weeks immediately preceding the Show. A relatively strong demand has now developed, however.

The Airplane Industry

Firms engaged in the airplane industry, and particularly those manufacturing light types of machines, are well employed. Two contracts which have been placed recently are deserving of special mention. The Chilean Government has ordered from the De Haviland Aircraft Co., forty Gypsy-Moth airplanes of the same type as the winning machine in the King's Cup race this year, while A. U. Roe & Co., Ltd., Manchester, have received an order from their distributors in the United States, Air Associates, Inc., of New York, for fifty 30 to 80 horsepower Cirrus Auro-Avian machines. This is stated to be the largest single order ever placed for light airplanes.

Shipbuilding Activities

Statistics issued by Lloyd's Register of Shipping indicate that the total tonnage of vessels under construction in Great Britain and Ireland at the end of September was 1,089,760. This figure shows a reduction of 112,850 tons in comparison with the corresponding total at the end of June. The total tonnage now under construction in the world amounts to 2,521,342, so that the share of Great Britain is 43.2 per cent.

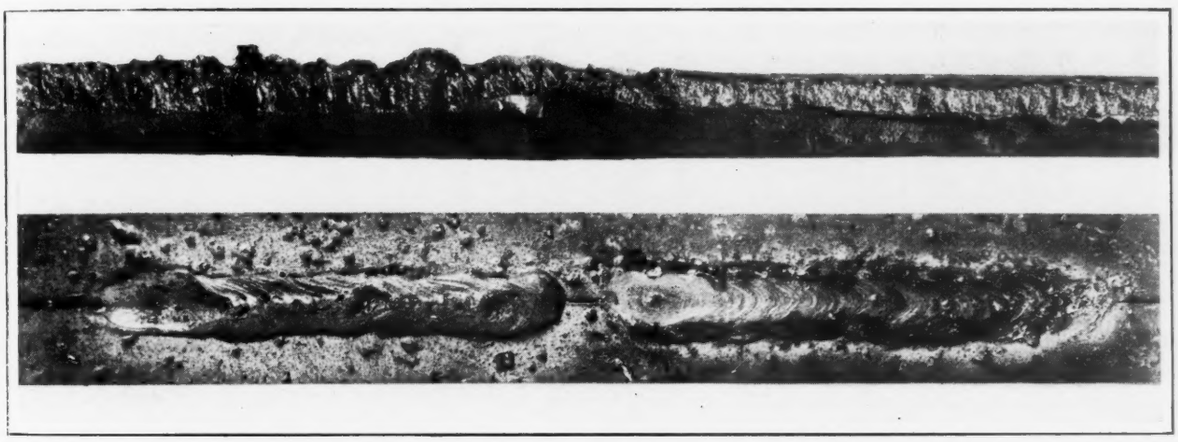
Iron and Steel Industries

According to figures issued by the National Federation of Iron and Steel Manufacturers, the production of pig iron in September amounted to 503,900 tons, compared with 519,000 tons in August; the daily rate of production in September was slightly higher than in August, being 16,797 tons, compared with 16,742 tons. The number of furnaces in blast increased by one during the month. Steel production in September amounted to 718,600 tons, an increase of some 70,000 over August, when production was curtailed by holidays.

NEW HIGH-SPEED WELDING ELECTRODE

A dense weld of unusual ductility obtainable at greatly increased speeds is the main feature claimed for a new welding electrode recently developed by the Research Laboratories of the Lincoln Electric Co., Cleveland, Ohio. In tests recently conducted, the speed of welding was doubled and trebled by the use of the new rod, which is known by the name "Fleet-Weld." The upper view of the illustration shows, at the left, a longitudinal section of weld metal deposited from ordinary wire at higher currents and speeds, while at the right is shown weld metal deposited from the "Fleet-Weld" electrode. The difference in density of the two weld metals is readily observed.

An incidental advantage of the new electrode is the smooth finish of its bead. This, in part, is caused by the higher speed obtainable with the new electrode, but is also, in part, inherent in the composition of the rod. The different appearance of the bead of ordinary wire used at higher currents and of the new electrode on a butt joint of 1/2-inch plate may be seen in the lower view of the illustration, the weld made with the new electrode being at the right.



Illustrations Showing the Density and Smooth Bead Obtained with "Fleet-Weld" Electrode

The light area around the beads indicates the extent of oxidation, while the bubbles of metal on the plates were caused by the spatter of molten metal when the ordinary wire was used. The absence of a crater in the bead of the new electrode is an indication of its smooth flow when in the molten state. Deep penetration is another feature of the new rod.

While the "Fleet-Weld" electrode has so far been a laboratory product, it is to be placed on the market in the near future.

* * *

OHIO MECHANICS INSTITUTE CELEBRATES ITS HUNDREDTH ANNIVERSARY

On November 20, 1828, the technical school known as the Ohio Mechanics Institute, of Cincinnati, was founded. The Institute commemorated this event by a centennial celebration which took place in Cincinnati, November 22 to 24. The main official event was held in the Emery Auditorium. Charles J. Livingood, president of the board of directors, presided. Murray Seasongood, mayor of Cincinnati, made the opening address, and Dr. Dexter S. Kimball, dean of the College of Engineering, Cornell University, followed as the principal speaker. Dean Kimball is also president of the Society for the Promotion of Engineering Education.

The celebration opened with a scene depicting the historic events that resulted in the founding of the Institute, the data upon which the scene was based having been secured from histories of early Cincinnati and old records of the school. Much of the dialogue in the scene was authentic, having been recorded at a meeting that took place in October, 1828, at the home of Dr. John Craig, one of the founders. Students in costume portrayed leading citizens of that time.

The Ohio Mechanics Institute is believed to be the first technical school in the Middle-west to celebrate its hundredth anniversary. It was the first chartered school established in the northwest territory. Many of the courses that are offered can be secured nowhere else, and the technique that has been developed there has been carried by its graduates to many other schools. The Institute is especially well known for its two-year intensive courses in commercial art, industrial mechanical engineering, industrial electrical engineering, power laundry technology, and its classes in lithography.

The building at the southwest corner of Sixth and Vine Sts., the home of the Institute for more than sixty years, was erected in 1848, the cornerstone being laid on July 4 of that year.

A regular night school was established in 1856 and systematic instruction imparted in mechanical, architectural, and freehand drawing. During the first fifty years of the night school nearly 20,000 students received instruction. Men are to be found in all parts of the country who received their technical education at the Institute.

In October, 1905, a new building site was acquired at the northeast corner of Walnut St. and Central Parkway. Five years later, the problem of funds to erect a new building was solved by the generous gift of Mrs. Mary M. Emery, who provided the Institute building as a memorial to her husband, Thomas J. Emery. Work was immediately started, and in the fall of 1911 the splendidly equipped building which is the present home of the Institute was ready for occupancy.

Mechanical Engineers Discuss Motor Drives

Machine Shop Practice Division at Annual Meeting in New York Will Consider Motor Drives for Different Types of Machine Tools

THE application of motor drives to different types of machine tools, especially lathes, planers, grinding machines, and multiple drilling and tapping machines, will be the subject of an entire session of the Machine Shop Practice Division of the American Society of Mechanical Engineers at the annual meeting to be held in the Engineering Societies Building, 29 W. 39th St., New York City, December 3 to 7. The motor application session will be held Tuesday morning, December 4.

At this session four papers will be presented. Charles L. Cameron of the Monarch Machine Tool Co., Sidney, Ohio, will read a paper on "Methods of Motor Application and Controls on Lathes." Forrest E. Cardullo, chief engineer of the G. A. Gray Co., Cincinnati, Ohio, will cover "Motors for Planer Service." R. E. W. Harrison, engineering director of the Cincinnati Grinders, Inc., Cincinnati, Ohio, will deal with "Motor Drives for Grinding Machines." J. H. Mansfield, chief engineer in charge of design of Greenlee Bros. & Co., Rockford, Ill., will present a paper on "Application of Motors to Special Drilling and Tapping Machines."

Motor Applications to Lathes

In his paper on the application of electric motors to lathes, Mr. Cameron points to the increasing popularity of individually motor-driven machine tools, and emphasizes the importance of the subject not only to the machine tool manufacturer, but to the user as well. Everyone is familiar with the rapid swing from the overhead countershaft drive for machine tools to the self-contained motor drive. During the last ten years the individually motor-driven lathes have stepped up from approximately 15 per cent of the total production of one lathe manufacturer to upward of 90 per cent today.

When the motor drive was first applied to lathes, the motors were mounted on top of the headstock and the driving was usually by means of either gears or silent chain. During the last four or five years, on lathe sizes of 20-inch swing downward, motors are often mounted inside of a cabinet base underneath the headstock. This method of mounting the motor has several advantages over mounting it on top of the headstock. It gives better light throughout the department, lessens vibration resulting from an improperly balanced motor, and makes the headstock unit more accessible.

Standardization of Motor Frame Sizes is Needed

Since there has been little or no standardization among motor manufacturers of frame sizes, armature-shaft dimensions, motor bolt-hole dimensions, etc., the application of a motor to a lathe is a case of fitting each one individually. Some of the difficulties experienced are as follows:

1. It is impossible to jig-drill and tap the motor plate.
2. It is necessary to fit each motor, lay out the holes, take the motor plate off the machine, drill and tap it, and then put it back again.
3. It is not possible to carry motor pulleys, sprockets, or sheave pulleys in stock, bored and keywayed ready for use; each must be made up after the motor has been selected.
4. It is impossible to carry standard motors in stock. Frequently considerable delay is experienced waiting for customers to send motors to the plant to be attached, which entails a loss of time and unnecessary freight expense.
5. Frequently customers neglect to have the proper starting apparatus sent at the same time with the motor, causing confusion and more delay, and making it impossible to attach and enclose the wires between motor and starter properly.
6. It is almost impossible for lathe builders to consider the use of flange mounting, due to the lack of standardization of frame sizes. In Germany, a number of lathe manufacturers have for some time used the flange mounting on the motor drive, for the reason that standardization of motors in Germany has advanced much further than here.

It is Suggested that the Lathe Manufacturer Provide the Motor

If the machine tool manufacturer could include the motor and controller in his machine as a component unit without identity, just as if it were a standard part of the machine, such as a speed gearcase, the problem would be greatly simplified. As the range of motors used on lathes is between 2 and 15 horsepower, with probably 90 per cent of the motors of 7 1/2 horsepower, and under, the manufacturer could carry in stock motors and starters of suitable voltage ready for instant application. The savings that would be effected if this practice could be adopted would be greater than those that the users now think they make by buying their own motors. Everyone is familiar with the number of questions that arise when ordering a motor-driven machine, such as horsepower, voltage, speed, style of starter, switches, etc. These details have to be settled with every order that is taken when customers order their own motors. Hence, it is evident that the buyer would save much time, expense, and confusion if the manufacturer of the machine provided the motor.

Also, when buyers supply their own motors, the manufacturer, to provide for the many varieties of motors, must design his machine so as to take almost any motor that may be selected. This causes considerable trouble and frequently spoils the symmetry of design.

Tendency to "Over-Motor"

An effective means of keeping down the original cost of installation on motor-driven lathes is not to "over-motor" the machine. There has been a tendency among lathe builders, as well as builders of other machine tools, to recommend motors of far greater horsepower for a given size of machine than is necessary.

Types of Motors for Lathes

Most motor-driven lathes are operated by a constant-speed alternating-current motor, on account of the prevalence of the use of alternating current. Because lathes must be operated at a number of speeds, a geared headstock is provided. When direct current is available, some use is made of the variable-speed motor, thereby securing a wide range of spindle speeds, either through the complete regular geared headstock or a simplified geared headstock.

Some use is made, on lathes, of the alternating-current, multi-speed, constant-horsepower motor, which can be secured with as many as four speed changes. However, the size of such motors and their expense has limited their use in this field. The development of an alternating-current, variable-speed, constant-horsepower motor of a reasonable size and price, having at least six or eight speed changes, would revolutionize the design of lathes, as well as many other classes of machine tools, and it is to be hoped that motor manufacturers are doing the necessary research and development to eventually produce such a motor.

Electric Motors for Planer Service

"The most satisfactory method for driving planers of medium and large size," says Mr. Cardullo in his paper, "Motors for Planer Service," "is by means of a reversing motor geared directly to the planer drive." Such motors are, with few exceptions, direct-current shunt or compound wound motors, having interpoles, or interpoles with compensating windings.

Planer manufacturers are frequently asked by customers if planers cannot be equipped with alternating-current reversing motors. A few alternating-current motors of the induction type have been built having two or more sets of stator windings, or having their stator windings so connected that the number of poles can be changed at will. The rotor is provided with slip rings so that resistance can be introduced into the secondary or rotor circuit, to limit the current reversal. Such a motor is more expensive and less efficient than a direct-current motor, and gives at most but two cutting speeds. The electrical design is relatively inflexible. Because of this inflexibility of design, the rotor is necessarily larger and heavier, and has a greater moment of inertia than would otherwise be necessary. This means more power consumed in reversal, lower efficiency, a more sluggish reversal, and a slower pickup after reversal.

Add to this objection the fact that only two cutting speeds are available, which reduces the production efficiency of the planer, and it is apparent that the alternating-current reversing motor drive labors under a heavy handicap. Such motors are most satisfactory when built for two speeds only, one of which is one-half the other.

Because of superior electrical and mechanical advantages, practically all reversing planer motors are of the adjustable-speed direct-current type. Such motors may be divided into two classes—constant-voltage motors where the speed is controlled by varying the strength of the shunt field current, and variable-voltage motors where, in addition to this method of control, a variable-voltage armature current is used for the lower range of speeds.

Motor Drives for Grinding Machines

"The cumbersome countershafts and the multiplicity of belts that characterized the earlier types of grinding machines imposed a handicap on production and added to the general unsightliness and lack of driving efficiency of the average machine shop," says Mr. Harrison in the opening paragraph of his paper on "Motor Drives for Grinding Machines." It was, therefore, only a matter of time before serious attention would be given to the elimination of countershafts, and a definite effort made not only to improve the appearance, but to add to the power-transmission efficiency of the machines. Particularly was this necessitated by the improvement made in the metal removal capacity of grinding wheels, calling for the application of much more power to the point of contact between the grinding wheel and the work.

Many of the earlier grinding machines had almost as much bulk of machinery attached to the ceiling as to the floor, and although accidents from this source were rare, it was generally considered by both users and manufacturers that this condition of affairs was a reflection on the mechanical ingenuity of all concerned.

It will be obvious to even the most casual observer that the tendency is all toward the elimination of the transmission elements. However, while this is a highly desirable trend on account of its simplicity, there are difficulties in the way of successful applications to grinding machines that do not obtain on other types of machine tools.

The one element that is the most prolific source of difficulty in the way of successful grinding operations is vibration, and until it is possible for motor manufacturers to produce motors that are free from vibration, it is doubtful if the practice of mounting the motor directly on the grinding-wheel spindle will become general.

Push-button control is now the order of the day. When the machine manufacturer supplies the electrical equipment, the push-button is invariably recommended. Contactor panels, operating in conjunction with a remote push-button control, must be placed in an accessible position, as they are all of the type that requires supervision.

"Across-the-Line" Motors for Grinding Machines

The "across-the-line" type of motor is rapidly becoming more popular, and while it costs a little more than the standard type of alternating-current motor, the switch gear is cheaper and offsets this extra cost. The chief advantage of the "across-the-line" equipment is its simplicity, and it is felt that it is only a matter of time before the electrical

power supply companies will so arrange matters that all machine tool equipment calling for motors up to 30 horsepower can be fitted with motors of this type.

At the present time many electric current supply companies are opposed to the installation of "across-the-line" motors on account of the rush of current involved in starting up. However, with such a motor and a suitable transmission element, having an adequate factor of safety to take care of the torque involved in starting up the mechanism, the load conditions represent the best combination that the user of today can buy.

Motors for Special Drilling and Tapping Machines

The paper by Mr. Mansfield deals particularly with the application of electric motors to single-purpose, multiple, fixed-spindle drilling, tapping, turning, boring, and facing machines, and emphasizes the advantages of variable- and multiple-speed motors.

The advantages and application of a new type of motor, known as the "can" type, which has been developed in the last few years, and is used almost exclusively in the woodworking machinery field, are outlined by Mr. Mansfield. This type of motor consists of a rotor and stator only. The stampings of the stator are held together by a thin steel sleeve about 1/16 inch thick, with its ends spun over the ends of the stack of stator stampings, binding them together—thus, the name "can" type. The motor manufacturers furnish the two parts, and the woodworking machine manufacturer mounts them in special housings to meet the conditions in the various types of machines.

These motors can be obtained in sizes ranging from a very small fraction of a horsepower up to 30 horsepower, and at various standard alternating-current motor speeds up to 3600 revolutions per minute, for 60-cycle current. When higher speeds are required, a frequency changer is used to increase or boost the 60-cycle current to either 90, 100, or 120 cycles, which, with a two-pole motor, will provide 5400, 6000, and 7200 revolutions per minute, synchronous speeds.

There is no reason why "can" type motors cannot be as successfully used in metal-working as in woodworking machines, except that the trade has not the spare motors to use in case of motor failures. A number of the larger users of woodworking machinery stock the different sizes of motors they use, and most of the large electrical companies carry a stock of the sizes most in demand at their various warehouses.

Complete copies of the papers on motor drive that are briefly abstracted in the preceding paragraphs may be obtained by applying to the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

* * *

The railroads of the United States purchase annually fuel, materials, and supplies to an amount of $1,400,000,000. Of this sum over $350,000,000 is accounted for by coal alone, and over $200,000,000 by rails and cross-ties. Seventy-two million dollars goes for frogs, switches, crossings, etc.

BUFFALO FORGE CO. CELEBRATES FIFTIETH ANNIVERSARY

The fiftieth anniversary of the Buffalo Forge Co., Buffalo, N. Y., is being celebrated this year, the business having been started in 1878 by Charles F. Brunke and Charles Hammelman, who began the manufacture of a portable forge originated by Mr. Hammelman. The first little shop was on the fifth floor of a humble building located at Washington and Perry Sts., Buffalo. A year later the two partners sold W. F. Wendt, a bookkeeper in the concern, a half interest in the business. The little forge concern soon began to make rapid strides. At first the company had outside machine shops make its products, but by 1880 the business was sufficient to warrant the purchase of its own manufacturing plant.

In 1884 the company entered the heating and ventilating field, and this line of equipment now constitutes the greater part of the factory's output. In 1888, Henry W. Wendt, brother of W. F. Wendt, was admitted to the firm. The new partner conceived the idea of the down draft forge, which was responsible for a rapid expansion of the business. In 1903 two other concerns were acquired. With the three companies under control, the business continued to grow until, in 1914, the three plants afforded employment to more than 1500 factory hands and 300 office employes.

In the early part of 1916, the company was reorganized and the following officers were elected: H. W. Wendt, president; E. F. Wendt, vice-president and treasurer; H. W. Wendt, Jr., vice-president and secretary; C. A. Booth, vice-president and sales manager; and H. S. Whiting, assistant secretary. All these men still continue to hold office.

* * *

MACHINERY INDUSTRIES DISCUSS PROBLEMS

A large number of trade associations in the machinery field, represented by officers and managers of the associations, met November 8 at Washington, in the building of the United States Chamber of Commerce, to discuss the common problems of the industry. Among the questions taken up for discussion were excessive demands for free engineering service, unfair trade practices, obsolete machinery offered for "trading in" purposes, demands of buyers for quantity discounts, etc. The meeting proved clearly that the same problems are pressing for solution in every branch of the machine-building industry, and that the different associations are in a position to aid each other by cooperating to eliminate harmful trade practices.

* * *

HOOVER AWARDED JOHN FRITZ MEDAL

The John Fritz Gold Medal, the highest honor bestowed by the engineering profession of this country, has been awarded for 1929, by the Engineering Foundation, to President-elect Herbert Hoover, in appreciation of his attainments as an engineer, particularly in mining operations in this and other countries, and of his great services to his fellowmen. The medal will be presented at the annual meeting of the American Institute of Mining and Metallurgical Engineers in February.

HORSEPOWER TRANSMITTED BY SPUR GEARS—III

Horsepower Transmitted by 14 1/2-degree Cut, Heat-treated Steel Spur Gears Having 1-inch Face (Working Stress 30,000 Pounds per Square Inch) (See Data Sheet 141 for further directions)

Diametral Pitch	Number of Teeth	Velocity in Feet per Minute											
		25	35	50	75	100	150	200	250	300	400	500	600
6	12	0.8	1.2	1.7	2.5	3.2	4.6	5.7	6.7	7.6	9.1	10.4	11.5
	14	0.9	1.3	1.9	2.7	3.5	4.9	6.1	7.2	8.2	9.8	11.2	12.3
	18	1.1	1.5	2.1	3.1	4.0	5.7	7.1	8.3	9.5	10.4	12.9	14.2
	24	1.2	1.8	2.5	3.6	4.6	6.5	8.2	9.6	10.9	13.1	14.8	16.4
	32	1.3	1.9	2.7	3.9	5.1	7.0	8.8	10.3	11.7	14.1	16.0	17.7
	48	1.4	2.1	2.9	4.2	5.4	7.6	9.5	11.2	12.7	15.3	17.3	19.1
	75	1.5	2.1	3.0	4.4	5.6	7.9	9.9	11.6	13.2	15.9	18.0	19.9
	125	1.5	2.2	3.1	4.5	5.8	8.2	10.2	12.0	13.6	16.3	18.5	20.4
	200	1.5	2.2	3.1	4.6	5.9	8.3	10.4	12.2	13.8	16.6	18.8	20.7
8	12	0.6	1.0	1.4	2.1	2.7	3.8	4.8	5.6	6.2	7.6	8.6	9.5
	14	0.7	1.1	1.5	2.2	2.9	4.1	5.1	6.0	6.8	8.2	9.3	10.3
	18	0.9	1.3	1.8	2.6	3.3	4.7	5.9	6.9	7.9	9.5	10.7	11.8
	24	1.0	1.5	2.1	3.0	3.8	5.4	6.8	8.0	9.1	10.9	12.3	13.6
	32	1.1	1.6	2.2	3.2	4.2	5.9	7.2	8.6	9.8	11.7	13.3	14.7
	48	1.2	1.7	2.4	3.5	4.5	6.4	7.9	9.3	10.6	12.7	14.4	15.9
	75	1.2	1.8	2.5	3.7	4.7	6.6	8.3	9.7	11.0	13.2	15.0	16.6
	125	1.3	1.8	2.6	3.8	4.8	6.8	8.5	10.0	11.3	13.6	15.4	17.0
	200	1.3	1.9	2.6	3.8	4.9	6.9	8.6	10.1	11.5	13.8	15.6	17.3
10	12	0.5	0.7	1.1	1.5	2.0	2.3	3.5	4.2	4.7	5.7	6.4	7.1
	14	0.5	0.8	1.1	1.7	2.1	3.1	3.8	4.5	5.1	6.1	6.9	7.7
	18	0.6	0.9	1.3	1.9	2.0	3.5	4.4	5.2	5.9	7.1	8.0	8.9
	24	0.7	1.1	1.6	2.2	2.9	4.1	5.1	6.0	6.8	8.2	9.2	10.2
	32	0.8	1.2	1.7	2.4	3.1	4.4	5.5	6.4	7.3	8.8	10.0	11.0
	48	0.9	1.3	1.8	2.6	3.4	4.8	5.9	7.0	7.9	9.5	10.8	11.9
	75	0.9	1.3	1.9	2.7	3.5	4.9	6.2	7.3	8.3	9.9	11.2	12.4
	125	0.9	1.4	1.9	2.8	3.6	5.1	6.3	7.5	8.5	10.2	11.5	12.7
	200	1.0	1.4	1.9	2.9	3.6	5.2	6.5	7.6	8.6	10.3	11.7	12.9
12	12	0.4	0.6	0.8	1.2	1.6	2.3	2.8	3.3	3.8	4.5	5.1	5.7
	14	0.4	0.6	0.9	1.3	1.7	2.4	3.0	3.6	4.1	4.9	5.5	6.1
	18	0.5	0.7	1.0	1.5	2.0	2.8	3.5	4.1	4.7	5.7	6.4	7.1
	24	0.6	0.9	1.2	1.8	2.3	3.2	4.1	4.8	5.4	6.5	7.4	8.2
	32	0.6	0.9	1.3	1.9	2.5	3.5	4.4	5.1	5.8	7.0	8.0	8.8
	48	0.7	1.0	1.4	2.1	2.7	3.8	4.7	5.6	6.3	7.6	8.6	9.5
	75	0.7	1.0	1.5	2.2	2.8	3.9	4.9	5.8	6.6	7.9	9.0	9.9
	125	0.7	1.1	1.5	2.2	2.9	4.1	5.1	6.0	6.8	8.1	9.2	10.2
	200	0.7	1.1	1.5	2.3	2.9	4.1	5.1	6.1	6.9	8.3	9.4	10.4
14	12	0.3	0.5	0.7	1.0	1.3	1.9	2.4	2.8	3.1	3.8	4.3	4.7
	14	0.3	0.5	0.7	1.1	1.4	2.0	2.5	3.0	3.4	4.1	4.5	5.1
	18	0.4	0.6	0.9	1.3	1.6	2.3	2.9	3.4	3.9	4.7	5.3	5.9
	24	0.5	0.7	1.0	1.5	1.9	2.7	3.4	4.0	4.5	5.4	6.1	6.8
	32	0.5	0.8	1.1	1.6	2.1	2.9	3.6	4.3	4.9	5.8	6.6	7.3
	48	0.6	0.8	1.2	1.7	2.2	3.2	3.9	4.6	5.3	6.3	7.2	7.9
	75	0.6	0.9	1.2	1.8	2.3	3.3	4.1	4.8	5.5	6.6	7.5	8.3
	125	0.6	0.9	1.3	1.9	2.4	3.4	4.2	5.0	5.6	6.8	7.7	8.5
	200	0.6	0.9	1.3	1.9	2.4	3.4	4.3	5.0	5.7	6.9	7.8	8.6

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MACHINERY'S Data Sheet No. 143, New Series, December, 1928 Contributed By A. Wasbauer

HORSEPOWER TRANSMITTED BY SPUR GEARS—IV

Horsepower Transmitted by 14 1/2-degree Cut, Heat-treated Steel Spur Gears Having 1-inch Face (Working Stress, 30,000 Pounds per Square Inch) (See Data Sheet 141 for further directions)

Diametral Pitch	Number of Teeth	Velocity in Feet per Minute									
		700	800	900	1000	1200	1400	1600	1800	2000	2400	3000
1	12	61.1	64.6	68.8	71.6	76.4	80.0	83.5	86.0	88.0	91.6	95.5
	14	65.7	69.5	74.0	77.0	82.2	86.0	89.8	92.5	94.6	98.5	103.0
	18	76.0	80.3	85.5	89.0	95.0	99.5	104.0	107.0	109.2	114.0	118.5
	24	87.3	92.3	98.3	102.0	109.0	114.0	119.0	123.0	126.0	131.0	136.5
	32	94.0	99.5	106.0	110.0	117.5	123.0	128.5	132.5	135.5	141.0	147.0
	48	101.8	107.6	114.8	119.2	127.4	133.4	139.0	143.4	146.6	152.6	159.0
	75	106.0	112.0	119.3	124.0	132.4	138.5	144.8	149.0	152.5	159.0	165.5
	128	108.8	115.0	122.2	127.5	136.0	142.5	148.6	153.0	156.8	163.0	170.0
	200	110.5	117.0	124.5	129.5	138.0	144.6	151.0	155.5	159.0	166.0	173.0
2	12	30.5	32.3	34.4	35.8	38.2	40.0	41.7	43.0	44.0	45.8	47.7
	14	32.8	34.7	37.0	38.5	41.2	43.0	44.9	46.2	47.3	49.7	51.5
	18	38.0	40.1	42.7	44.5	47.5	49.7	52.0	53.5	54.6	57.0	59.2
	24	43.6	46.1	49.1	51.0	54.5	57.0	59.5	61.5	63.0	65.5	68.2
	32	47.0	49.7	53.0	55.0	58.5	61.5	64.2	66.2	67.7	70.5	73.5
	48	50.8	53.8	57.4	59.6	63.7	67.7	69.5	71.7	73.3	76.8	79.5
	75	53.0	56.0	59.6	62.0	66.2	69.2	72.4	74.5	76.2	79.5	82.7
	128	54.4	57.5	61.1	63.7	68.0	71.2	74.3	76.5	78.4	81.5	85.0
	200	55.2	58.5	62.2	64.7	69.0	72.3	75.5	77.7	79.6	83.0	86.5
2½	12	24.4	25.8	27.5	28.7	30.6	32.0	33.4	34.2	35.2	36.7	38.2
	14	26.5	27.8	29.6	30.8	32.4	34.4	35.9	37.0	37.8	39.4	41.2
	18	30.4	32.1	34.2	35.6	38.0	39.8	41.6	42.8	43.7	45.6	47.5
	24	35.0	37.0	39.3	40.8	43.6	45.6	47.6	49.2	50.4	52.4	54.6
	32	37.6	39.8	42.4	44.0	47.0	49.2	51.4	53.0	54.2	56.4	58.8
	48	40.6	43.0	45.9	47.7	51.0	53.4	55.6	57.4	58.6	61.0	63.6
	75	42.5	44.8	47.7	49.6	53.0	55.4	57.8	59.6	59.6	63.6	66.3
	128	43.5	46.0	48.9	51.0	54.4	57.0	59.4	61.2	62.7	65.2	68.0
	200	44.2	46.8	49.8	51.8	55.2	57.8	60.3	62.2	63.7	66.4	69.2
3	12	20.4	21.5	22.9	23.9	25.5	26.7	27.8	28.7	29.3	30.5	31.8
	14	21.9	23.2	24.7	25.7	27.4	28.7	29.9	30.8	31.5	32.8	34.3
	18	25.3	26.8	28.5	29.7	31.7	33.2	34.7	35.7	36.4	38.0	39.5
	24	29.1	31.4	32.8	34.0	36.3	38.0	39.7	41.0	42.0	43.7	45.5
	32	31.3	33.2	35.3	37.3	39.2	41.0	42.8	44.2	45.2	47.0	49.0
	48	33.9	35.9	38.3	39.7	42.5	44.5	46.3	47.8	48.9	50.9	53.0
	75	35.3	37.3	39.8	41.3	44.1	46.2	48.3	49.7	50.8	53.0	55.2
	128	36.3	38.3	40.8	42.5	45.3	47.5	49.5	51.0	52.3	54.3	56.7
	200	36.8	39.0	41.5	43.2	46.0	48.2	50.3	51.8	53.0	55.3	57.7
4	12	15.3	16.2	17.2	17.9	19.1	20.0	20.9	21.5	22.0	22.9	23.9
	14	16.7	17.4	18.5	19.2	20.5	21.5	22.4	23.1	23.4	24.6	25.7
	18	19.0	20.1	21.4	22.2	23.7	24.9	26.0	26.7	27.3	28.5	29.6
	24	21.8	23.1	24.6	25.5	27.2	28.5	29.7	30.7	31.5	32.7	34.1
	32	23.5	24.9	26.5	27.5	29.4	30.7	32.1	33.1	33.9	35.2	36.7
	48	25.4	26.9	28.7	29.8	31.8	33.3	34.7	35.8	36.6	38.1	39.7
	75	26.5	28.0	29.8	31.0	33.1	34.6	36.2	37.2	38.1	39.7	41.4
	128	27.2	28.7	30.6	31.9	34.0	35.6	37.1	38.2	39.2	40.7	42.5
	200	27.6	29.2	31.1	32.4	34.5	36.1	37.7	38.9	39.9	41.5	43.3

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MACHINERY'S Data Sheet No. 144, New Series, December, 1928 Contributed By A. Wasbauer

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

MORTON LOCOMOTIVE-CYLINDER FINISHING MACHINES

All planing, boring, and milling operations on locomotive cylinders can be performed in a machine recently built by the Morton Mfg. Co., Muskegon Heights, Mich., with the result that the cylinders are completely finished, except for drilling, when they leave the machine. The cylinders are first placed on the floor chucks for the boring operations. The piston-valve chamber is then bored and faced by means of the piston-valve boring unit, while the main barrel is bored and faced at the same time by employing the traveling head unit.

When the boring operations are completed, the cylinder is placed in special chucks for the planing and milling operations. Then the travel-head unit is moved over to the work for the planing and milling. In the meantime, a new cylinder can be placed in the floor chucks and made ready for boring as soon as the planing and milling are finished. In this way, the machine can be kept in constant operation.

The general construction of the machine is similar to Morton traveling head planers. When operated as a planer, the machine feeds either horizontally on the bed or vertically on the column. For boring and milling, there are automatic ram feeds. The gear-box provides eight feed changes in each direction, the different feeds being started and stopped by one lever. Rapid power traverse is provided for all motions.

The floor plate is made in two sections, and measures approximately 15 by 20 feet. Cylinder chucks of the three-jaw universal type are used, having jaws that are expanded into the counterbore of the cylinders. The main barrel boring outfit consists of a boring-bar, cutter-heads, and an outer support, the boring-bar being 5 inches in diameter. The port milling attachment can be quickly attached to the square section of the ram without removing the standard planer head. A 10-inch face mill is included in the regular equipment for milling operations.

A one-piece work-table, 30 inches high, 36 inches wide, and 8 feet long, is usually furnished. This table is especially suitable for holding frames and other large work which may be finished in the machine when there are no cylinders to be finished. There is a special extension head designed for planing the upper frame fit of piston valve cylinders.

This machine is driven by a 10-horsepower reversing-type motor which delivers power through miter gearing and a vertical shaft to the operating mechanism in the vertically moving apron. The reciprocating motion of the ram is controlled entirely

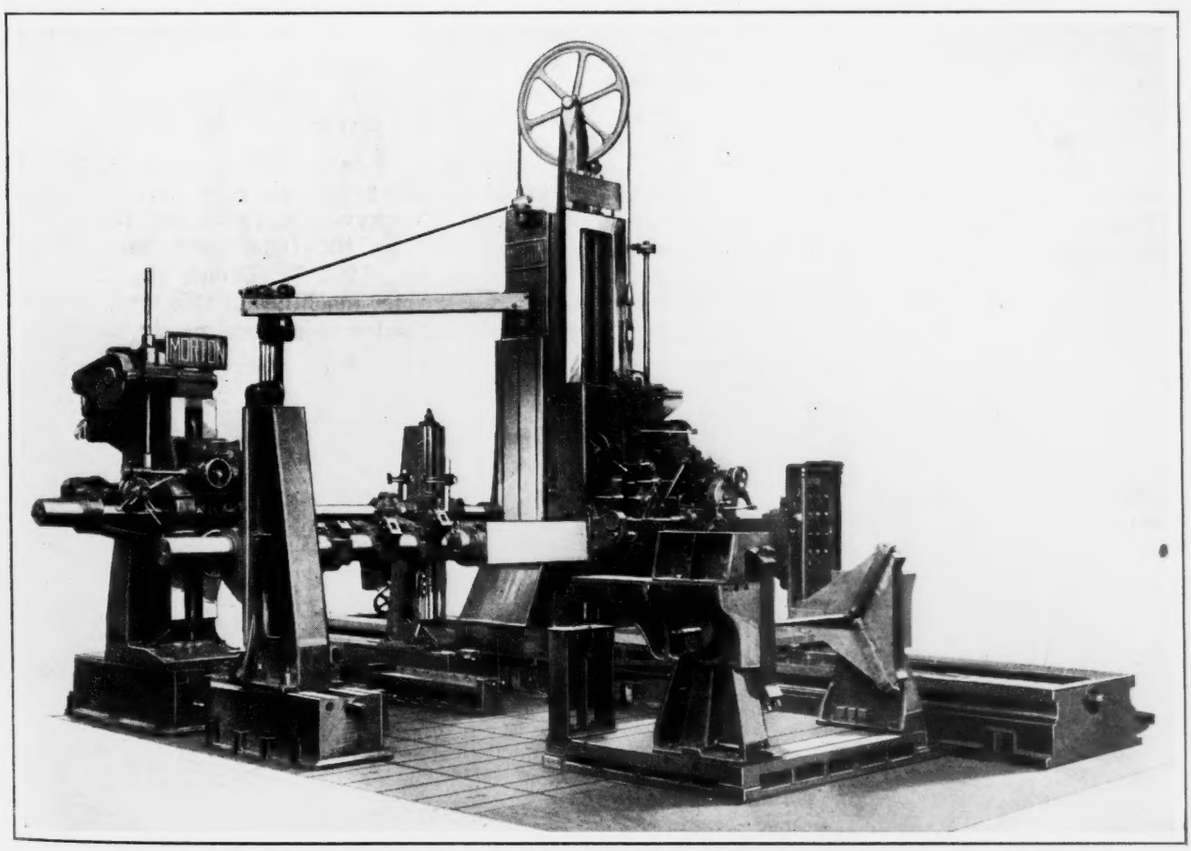


Fig. 1. Morton Machine Designed to Perform All Planing, Boring and Milling Operations on Locomotive Cylinders

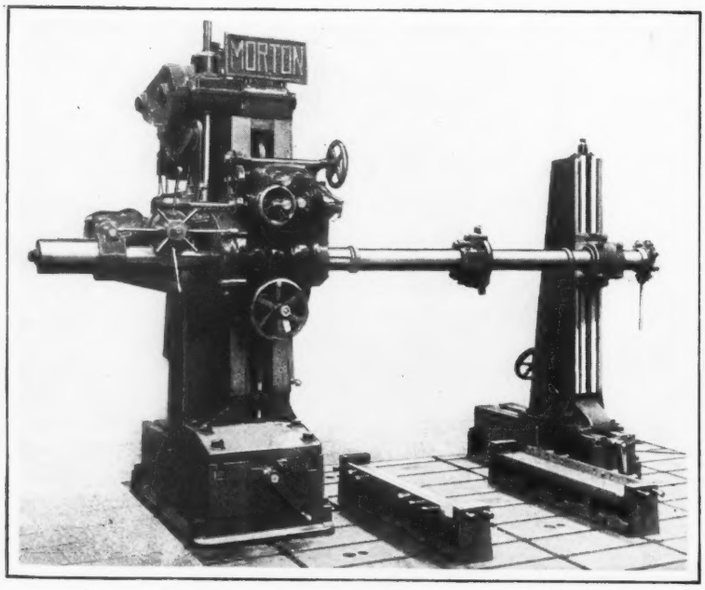


Fig. 2. Equipment for Boring Piston-valve Chambers of Locomotive Cylinders

by the reversing motor drive. The machine has a stroke of 72 inches, a vertical feed of 96 inches, and a horizontal feed of 18 feet. However, both the vertical and horizontal feeds can be increased by providing a taller column and longer bed. Also, two traveling head units can be mounted on one bed to make a double-head machine. Cylinders larger than those in use today can be accommodated with this equipment.

Another addition to the line of railroad shop machines built by the Morton Mfg. Co., is the horizontal equipment illustrated in Fig. 2, which is designed for boring the piston-valve chamber of locomotive cylinders. This equipment has an arbor 5 inches in diameter, which is bored to a No. 7 Morse taper. It has an automatic feed of 14 inches horizontally, there being six feed changes. Vertical and horizontal adjustments of the machine are made by hand. Scales are provided for these horizontal and vertical movements.

There is an outer bearing for the boring-bar, which has 44 inches of vertical movement and 24 inches of horizontal adjustment. Two parallels are furnished for use in setting and leveling the cylinder to be bored. Set-screws are provided for raising and lowering the cylinder and for moving it sideways, while ample provisions are made for clamping down the cylinders.

This unit is driven by a 7 1/2-horsepower direct-connected motor. Power is transmitted through a silent chain, running in oil, to the gear-box and friction clutch. The control levers are conveniently located. The unit can be started and stopped independently of the motor.

LINK-BELT SILENT CHAIN DRIVES

The line of silent chain drives built and kept in stock by the Link-Belt Co., 300 W. Pershing Road, Chicago, Ill., has been extended to include larger units. In 1924 the plan of furnishing silent chain drives from stock was inaugurated, and at that time drives from 1/2 to 10 horsepower were made available. In 1926 the range was increased to 15 horsepower. The present announcement is to the effect that the demand for drives from stock has made it necessary to increase the range to 60 horsepower. According to the latest silent chain stock book No. 725, issued by the company, these drives are available in practically any reduction from 1 to 1 to 7 to 1, for immediate delivery, from distributors in the principal cities of the United States.

This plan of keeping certain sizes in stock does not in any way affect the range of horsepowers available in the silent chain engineering drives which the company is prepared to furnish to industry in sizes up to 1000 horsepower and larger. The silent chain drives of the Link-Belt Co., are made at the Dodge Works, Indianapolis, Ind.

BRIDGEPORT HEAVY-DUTY KNIFE AND FACE GRINDER

Increased work-table speeds and a wider range of speeds are the principal improvements embodied in a type 74 heavy-duty knife and face grinder recently built by the Bridgeport Safety Emery Wheel Co., Inc., 1283 W. Broad St., Bridgeport, Conn. On former machines of this type, the maximum table speed was approximately 20 feet per

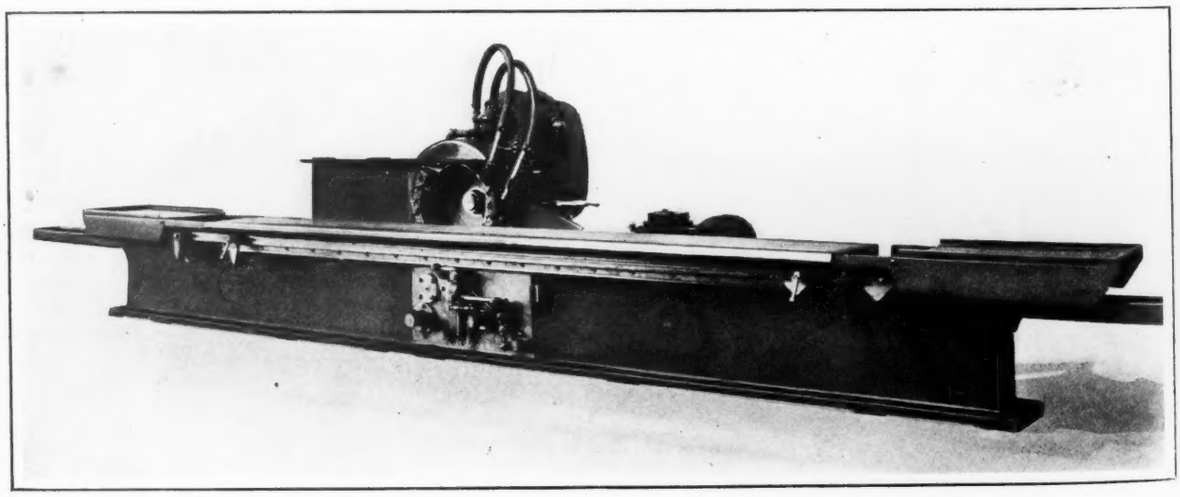


Fig. 1. Bridgeport Knife and Face Grinding Machine with Oilgear Table Drive

minute, whereas on the new machine the maximum speed is 90 feet per minute. The minimum speed is 5 feet per minute, and any desired speed between minimum and maximum is obtainable, the machine being equipped with an Oilgear table drive. Various speeds, which are indicated on a dial, are secured by operating a handwheel.

Another improvement of the machine lies in the grouping of controls in such a manner that the operator can change the work speed at any time without moving from his normal position, reverse the direction of work travel by merely depressing a foot-treadle, regardless of the direction in which the table is traveling; feed the grinding wheel up to the work, either by hand or automatically; and vary the amount of automatic feed at will. The automatic feed can be varied from 0.00025 to 0.010 inch in steps of 0.00025 inch, the desired feed being obtained by merely setting a dial. The grouping of controls may be seen in Fig. 2.

All gearing is splash lubricated and self-maintaining for long periods of time. Coolant arrangements have been materially improved, both as to the quantity and control of the coolant. A centrifugal pump which supplies 60 gallons of coolant per minute has been installed. Two fully adjustable nozzles direct the coolant to the work and wheel.

The machine is driven by three electric motors. The large motor that drives the grinding wheel is connected to it by a silent chain which is fully enclosed and runs in an oil bath. The coolant pump is coupled direct to another motor, while the variable-delivery oil-pump is driven by a third motor through a flexible coupling.

Either an angle-bar or a revolving knife bar is furnished with the machine. The knife bar is rigidly supported by two end bearings and as many intermediate bearings as the length of the bar may require. The bar can be revolved to any desired angle by means of a handwheel. Knives may be set up for grinding either to or from the edge. Heavy knives can be clamped to the angle-bar without springing or distorting it. Magnetic angle-bars, knife bars, or chucks can also be furnished.

The machine is built in nominal table lengths of from 50 to 206 inches, the total table lengths ranging from 8 feet 9 inches to 21 feet 9 inches, while the bed length on the floor ranges from 6 feet 3 inches to 25 feet 10 inches.

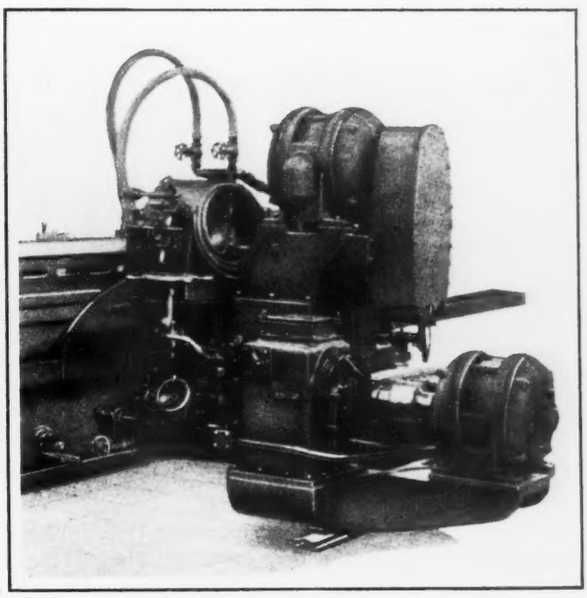
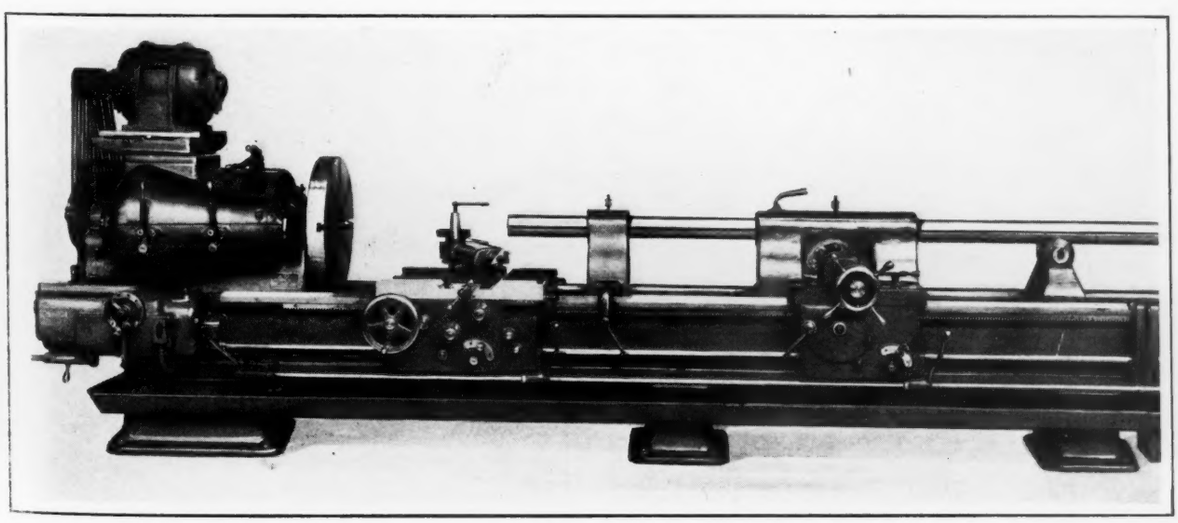


Fig. 2. Centralized Control of Bridgeport Grinder

BOYE & EMMES TUBE BORING LATHE

A special lathe designed for boring tubes from 3 1/4 to 8 inches in diameter has recently been built by the Boye & Emmes Machine Tool Co., Cincinnati, Ohio. The machine, as illustrated, consists of the regular headstock, carriage, feed-box, and bed of the builder's 24-inch engine lathe. In addition, a special or auxiliary tailstock, an apron attached to this tailstock, a front support for the boring-bar, and a rear roller support are provided.

The auxiliary tailstock carries the boring-bar, and may be moved along the bed by turning a hand-operated lever which actuates a pinion along a rack. The tailstock can be locked in any position on the bed. The apron attached to the tailstock is connected to the feed-rod of the lathe through a series of gears by means of which, together with a rack on the under side of the boring-bar, longitu-



Boye & Emmes Lathe Designed for Boring Tubes from 3 1/4 to 8 Inches in Diameter

dinal motion is transmitted to the boring-bar. A clutch and the star handwheel shown permit the bar to be rapidly traversed by hand. The apron is also provided with a reversing lever which is operated to traverse the bar by power.

The front support for the bar has a rack-and-pinion traverse, obtainable by hand, and may be locked in any position on the bed. Both the tailstock and the front bar support are bored to take the largest bar for which the machine is designed; reducing bushings are used to suit smaller sizes of bars as required. The overhanging rear end of the bar is carried by an adjustable roller support which is moved along the bed by hand.

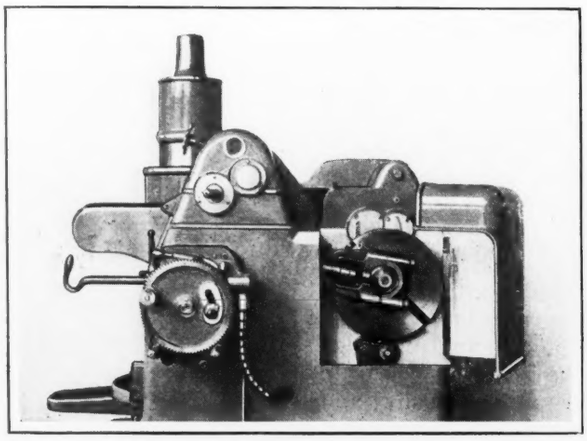


Fig. 1. Right-hand End of Fellows Gear Shaper with Guards Removed to Show the Drive Connections

The auxiliary tailstock can be provided with a center, locked in place, and used as a regular tailstock for ordinary turning. A lever on the auxiliary carriage is used for starting and stopping the headstock spindle. There is a motor-driven high-pressure pump which supplies cutting lubricant from a forty-gallon tank. The lathe also has a pan running its entire length, for the cutting lubricant.

FELLOWS PRODUCTION GEAR SHAPER

Spur and helical gears, both external and internal, can be produced in a new type of gear shaper particularly adapted to production work which has recently been placed on the market by the Fellows Gear Shaper Co., 78 River St., Springfield, Vt. This 6A type machine has a capacity for external gears up to 18 inches pitch diameter and 5 inches face width, and internal gears up to 18 inches pitch diameter and 3 inches face width.

This machine does not differ fundamentally in operation from the gear shapers formerly built by the company, but a considerable improvement has been made over the No. 6 shaper in that the new machine is of more rigid construction and is fully automatic in operation. The double-cut mechanism has been retained, but it is now completely automatic, so that when the gear being cut has made either one or two complete revolutions, depending upon the number of cuts to be taken, the machine stops automatically.

One particular feature of the new machine is the apron design. The apron is operated by cams, and is positively controlled in both directions; that is, it is held into the seat in the base positively by a cam, and is also withdrawn from its seat positively by a cam to relieve the work from the cutter on the return stroke. This mechanism operates efficiently and quietly.

Another important feature of the machine is the drive for the cutter-slide. The machine is driven by a single pulley from which power is delivered through a change-gear box controlled by interlocking levers, to a heavy crankshaft which is designed to absorb any vibration. Four reciprocating speeds of the cutter-slide are provided, ranging from 111

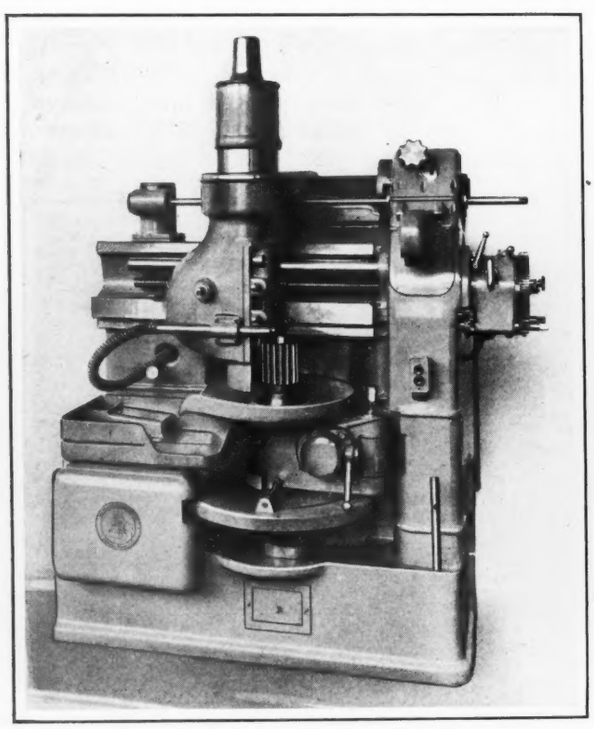


Fig. 2. Fellows Production Type Gear Shaper

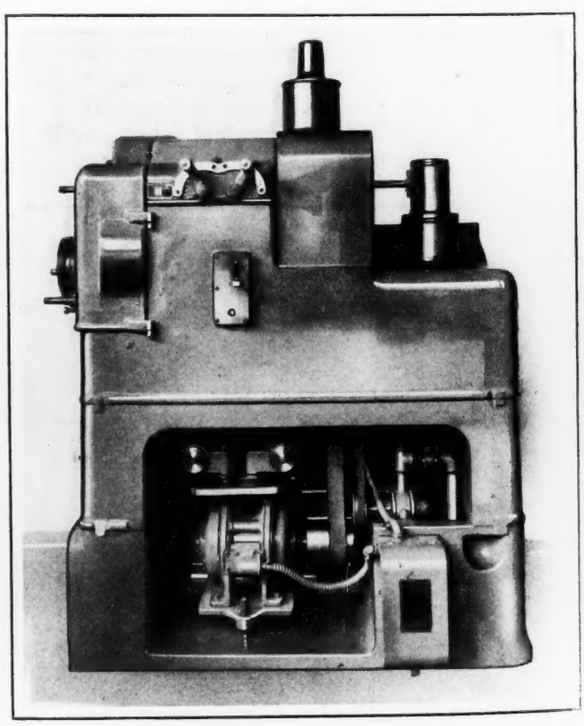


Fig. 3. Rear View with Guard Removed, Showing Motor Drive

to 400 strokes per minute. The feed or rotative speed of the cutter and work is also controlled by a change-gear box, which provides six feeds ranging from 720 to 1620 strokes of the cutter per complete revolution. Feeds can be selected while the machine is in operation.

All high-speed rotating shafts are mounted on ball bearings, and ball bearings are used in other places where their application is desirable. High-speed shafts are automatically lubricated from a pump in the speed gear-box. The lubricant is pumped into a reservoir in the feed gear-box, from which it is fed by wicks and piping to the various bearings throughout the machine, with the exception of those on the saddle. The saddle has a reservoir in the index-wheel housing that furnishes lubricant to the reciprocating and rotating members of the saddle. All working members of the machine are enclosed either with removable or fixed guards to insure safety of the operator. Machine members requiring adjustment are easily accessible.

This machine is arranged with a compartment in the base for motor drive, as illustrated in Fig. 3, and a three-horsepower alternating-current motor is recommended. The main drive shaft speed is 1250 revolutions per minute, and a motor operating at 1800 revolutions per minute meets the requirements. The net weight of the machine is approximately 5800 pounds.

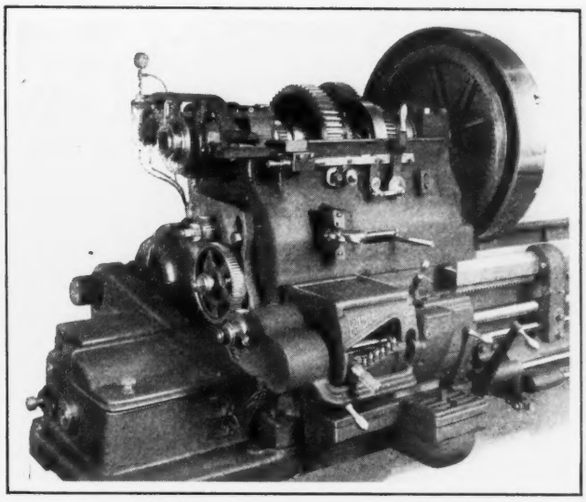


Fig. 1. Head of "Lowdrive" Lathe, with Guards Removed

The machine is built in three different styles, designated Nos. 61A, 612A, and 615A. The No. 61A machine is intended particularly for arbor work. It has a removable sleeve in the work-spindle which is used for holding standard gear shaper work-arbors. The cutter-spindle receives cutters of 3 and 4 inches pitch diameter, having a 1 1/4-inch hole.

The No. 612A machine has a large cutter-spindle designed to receive 4-inch cutters only, having a 1 3/4-inch hole. This machine is recommended for work of coarser pitch than the No. 61A gear shaper. The No. 615A machine is adapted for cutting spur, helical, and herringbone gears, both internal and external. For cutting helical gears, cutters of 3 1/2 inches pitch diameter, having a 1 1/4-inch hole are used, whereas for cutting spur gears, 4-inch cutters only, having a 1 1/4-inch hole, are used. In order to cut spur gears on this machine, straight guides are substituted for helical guides, and vice versa.

BRADFORD "LOWDRIVE" ALL-GEARED MOTOR-DRIVEN LATHE

A "Lowdrive" all-geared lathe of completely new design has just been added to the line of equipment built by the Bradford Machine Tool Co., 657-671 Evans St., Cincinnati, Ohio, in two sizes of 42 and 48 inches swing. One of the principal features of

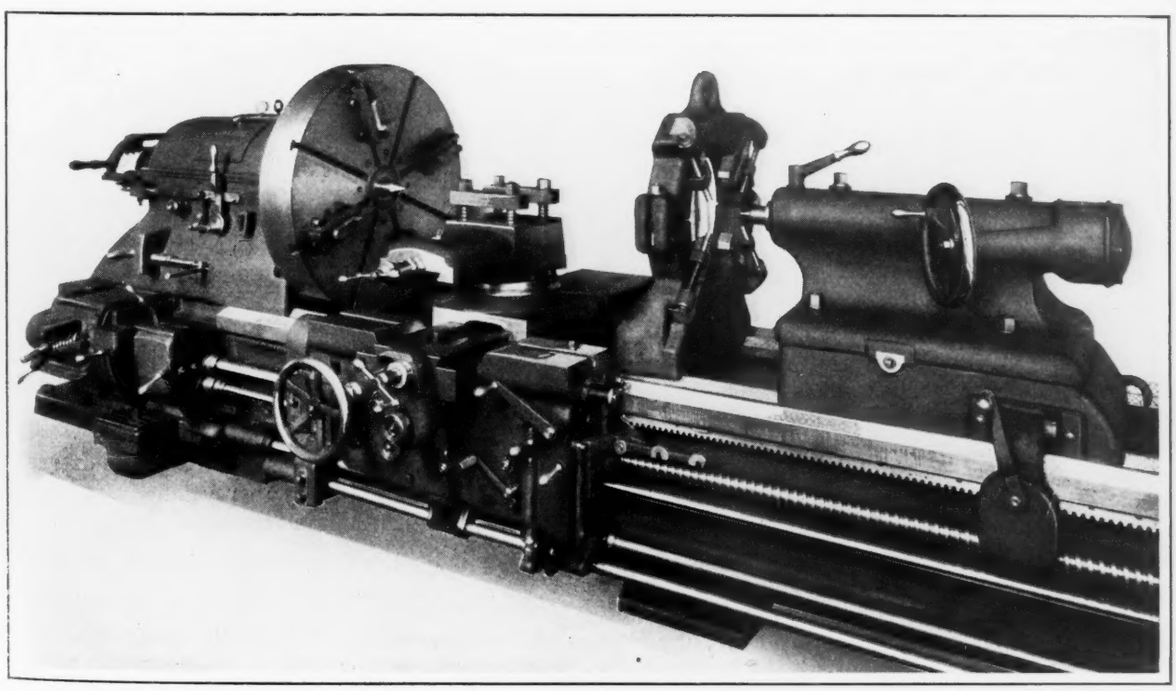


Fig. 2. Bradford 42-inch "Lowdrive" All-geared Lathe

this lathe is the all-geared transmission, which is of an unusually heavy design due to the fact that about two-thirds of the drive is placed entirely under the head and down in the bed where six selective initial speed changes are controlled and locked by means of a single lever. From this gearing, the power is delivered through a heavy flexible chain to the initial drive in the lower front part of the head. The down pull on the chain, which increases with heavier cuts, is a big factor in obtaining rigidity between the head and bed. This arrangement is covered by a patent.

In addition to the spindle, the head itself carries a back-gear drive, a triple or faceplate drive, and a direct spindle drive. The construction enables a tumbler to be used in the head for providing the various feeds and "threads," as well as a mechanism having two coarse screw ratios (4 and 20)

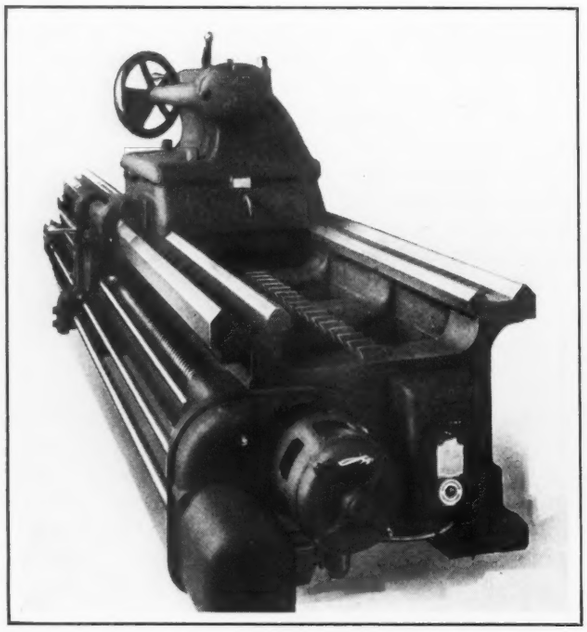


Fig. 3. Construction of Bed and Location of Power Rapid Traverse Motor

which materially increases the threading and feeding range listed on the regular index-plate. A lead of 20 inches is regularly available.

Eighteen forward and reverse spindle speeds ranging from 1 1/2 to 175 revolutions per minute are obtainable. There is a spindle brake which acts automatically when the drive to the spindle is disengaged. The faceplate drive is controlled by a single shift of a large lever which moves the engaging pinion into or out of mesh with the internal face gear. With this drive engaged, the operator uses the apron control entirely to start, stop, and reverse the lathe spindle.

Power rapid traverse is available for moving the carriage in either direction along the bed, for the carriage cross-feed screw and tool-rest, and for the angular feeding mechanism to the compound rest top. Engagement of the power rapid traverse is accomplished by simply holding down a lever on the carriage until the required movement has been effected. It is impossible to engage the power rapid traverse until the power feed has been disengaged and vice versa. An independent motor is mounted on the bed at the right-hand end, as shown in Fig. 3, to meet all power rapid traverse requirements.

The oiling of each bearing is automatic, fresh oil being regularly supplied in amounts adjusted to suit the different bearings. For this purpose, an automatic oil-pressure accumulator is supplied, which discharges oil at a pressure of about 300 pounds at fixed intervals, as long as the lathe is running.

The lead-screw is not splined, being used for thread-cutting only. A precision master screw is employed in chasing the lead-screw thread, and the lead is guaranteed to be accurate within 0.001 inch in 18 inches, for the full length of the thread. The feed-rod and the lead-screw cannot be engaged at the same time. The quick-change gearing for obtaining the different feeds and "threads" is of the Bradford design used for many years.

The machine is usually furnished with a 25-horsepower constant-speed motor, which runs continuously in one direction. Starting and stopping of the motor is effected through a push-button station located on the head, or in any other convenient place, or in several places. Independent starting, stopping, and reversing of the lathe is effected by means of a lever on the carriage. There are also knobs on the carriage for engaging the power longitudinal feed and the power cross-feed, either plain or angular, as well as a lever for engaging the half-nuts with the lead-screw. The reverse handle for the feeds, as well as the rapid traverse lever which controls the separate motor for traversing the tool carriage in either direction, is also located on the carriage. An automatic stop is regularly provided for the carriage. In addition, there is a chasing dial which can be swung into an inoperative position when the lathe is not being used for chasing threads.

Lead screw and rod hangers, carefully fitted to carry the weight of these parts, are furnished. These hangers are engaged and released by means of hooks, attached to both sides of the carriage, in such a way that they are pushed or pulled along the outer bed vee and automatically locate themselves at fixed intervals so as to afford an adequate support for the lead-screw and rod. One of the features of the tailstock is the arrangement of the handwheel which allows the operator to center work or perform boring operations with minimum effort. The heavy pawl rack furnished for the tailstock may be seen in Fig. 3. The bed is of deep planer type construction.

A taper attachment can be supplied having a taper-turning capacity of 6 1/2 inches per foot for the full distance between centers. A steadyrest, with 18 1/2 inches of opening and screw-adjustable jaws, is also part of the regular equipment. Follow and full-swing rests can be furnished as extras, as well as gears and index-plates for cutting especially fine or coarse threads or metric threads.

"SOLDALUME"—AN ALUMINUM SOLDER

A white powder with which aluminum and all its alloys can be soldered at temperatures ranging from 350 to 400 degrees F. is being placed on the market by the Aluminum Solder Corporation of

America, 730 Fifth Ave., New York City. This powder is known as "Soldalume." High ultimate strengths are claimed for joints soldered with this material, tests having shown that butt joints of duralumin to duralumin have an ultimate strength up to 30,000 pounds per square inch, and that butt joints of aluminum to aluminum have an ultimate strength up to 12,000 pounds per square inch. Temperatures of about 800 degrees F. are required to destroy the soldered joints. The solder does not corrode even in salt-laden moist air.

In applying "Soldalume," the parts to be soldered are first cleaned with emery cloth, a file, or by scraping the surfaces to be joined. Then, with the parts held in a fixture, the powder is applied to the joint in fair quantity, after which the parts are heated with an ordinary gas flame, that is, with a Bunsen burner or a blow-torch. Care must be taken to see that the flame does not touch the powder. As soon as the heat has been applied for a few seconds, the powder melts, bubbles, and flows into the joint. It then gives off a thick white smoke, and when this ceases, the joint is finished. The parts are next dipped in water or left to cool in the air, the former method being preferable.

GLEASON COMBINATION LAPPING AND TESTING MACHINE

One of the latest machines to be developed by the Gleason Works, Rochester, N. Y., for use in the production of spiral-bevel and hypoid gears is the 18-inch combination testing and lapping machine here illustrated. Gears are first tested in this machine after being cut, to determine the tooth bearing. After hardening, they are again tested, both for bearing and noise. A brake on the gear or driven head enables gears to be tested under load.

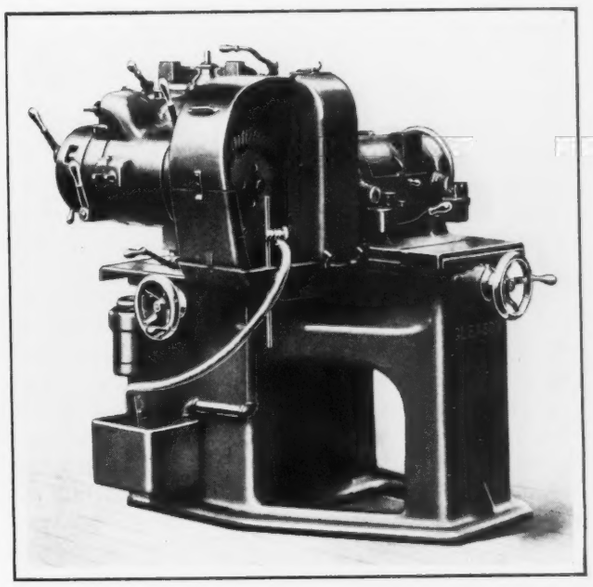
In lapping a pair of spiral-bevel or hypoid gears, it is customary to vary the settings so that the tooth surfaces will be lapped all over. The principle on which the new machine is based is such that any adjustment or motion will not be in a horizontal or vertical direction only, but in a combination of the two, and in proper proportion so that the motion follows the tooth curve already generated. The machine makes this motion automatically, and is so arranged that the direction of the motion can be changed to suit any job.

Gears up to 18 inches pitch diameter can be lapped. The maximum offset obtainable in testing hypoid gears is 3 1/2 inches, and the maximum distance from the center of the gear spindle to the nose of the pinion spindle is 12 inches, while the minimum distance is 3 7/8 inches. Some of these values are varied a little when the lapping guards are in place. For lapping operations, the machine is equipped with guards, a pump, and a reservoir for the lapping compound. The pump unit is a complete mechanism with a built-in motor. The lapping guards are split at the top to facilitate removing large gears from the machine.

The taper hole in the nose of the work-spindle is ground with the spindle in place in its own bearings, so as to insure concentricity between the spindle bearings and the bore. The spindle is mounted on improved type, matched ball bearings, which are installed under a sufficient initial load so that there is no evidence of radial or axial deflection of the spindle under ordinary operating conditions. These bearings are carefully tested for quietness and are so nearly silent that the operator has no difficulty in detecting gear noise.

The drive spindle can be run in either direction. It is provided with a lock used in tightening or loosening arbor nuts. The pinion-head and the gear-head column are adjustable horizontally on the frame by handwheels graduated to 0.001 inch. The pinion-head and the gear-head column are clamped to the frame at the front and rear by separate clamps, operated under equal tension by means of a single lever.

A five-horsepower motor having a speed of 1800 revolutions per minute is required for the main drive. It is set in the machine base. This motor may be furnished by the customer, but the Gleason



Gleason Lapping and Testing Machine for Spiral-bevel and Hypoid Gears

Works supplies two small motors, one for the oscillating motion and the other for driving the lapping compound pump mechanism. The machine cannot be arranged for a belt drive.

"MIL-WAUKEE-MIL BROADSIDE" FACE MILLING MACHINES

Large cylinder blocks, side frames, and other heavy castings to be machined with a face milling cutter can be handled by a new series of "Broadside" milling machines recently added to the "Mil-Waukee-Mil" line built by the Kearney & Trecker Corporation, Milwaukee, Wis. The machines of the "Broadside" series have as their foundation either a "Mil-Waukee-Mil" Simplex or Duplex machine, the principal difference being that a special face milling head mounted directly on the bed of the new machines replaces the standard head of a Simplex machine, and two of these face milling heads, in like manner, replace the standard heads of Duplex machines. Should the nature of the work demand it, only one head of the Duplex ma-

chine need be replaced, thus leaving a standard head opposite the face milling head. (A complete description of the Simplex and Duplex "Mil-Waukee-Mil" machines was published in October, 1927, MACHINERY, page 145.)

The face milling head of "Broadside" milling machines is fitted with the standardized spindle nose which accommodates any size of cutter up to 24 inches in diameter. Larger diameter cutters are bolted to the faceplate and are driven by clutch keys. The entire head is automatically lubricated, and is equipped with Timken tapered roller bearings throughout.

The main spindle on which the faceplate is mounted is 5 3/8 inches in diameter. It has a front Timken bearing 8 1/2 inches in diameter, and a rear Timken bearing 6 inches in diameter. On the back of the faceplate and integral with it, as seen in Fig. 2, there is an internal gear 20 1/2 inches in diameter, having 82 teeth of 4 diametral pitch. The shaft and pinion that drive this internal gear receive power through large spiral-bevel gears, the ratio of the drive pinion to the internal gear being approximately 8 to 1.

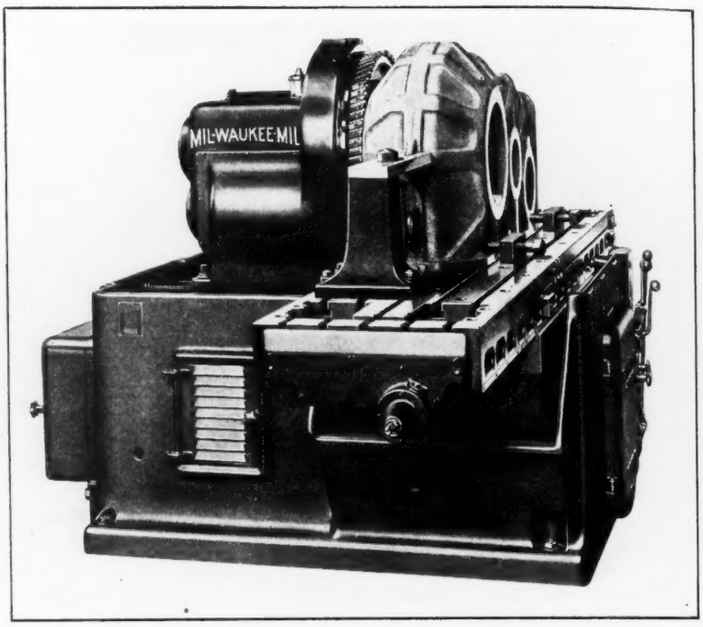


Fig. 1. "Broadside" Face Milling Machine Built by the Kearney & Trecker Corporation

In addition to the driving pinion shaft, there is also an auxiliary free-running idler shaft, as may be seen from the end view in Fig. 2. While the driving pinion shaft transmits power to the internal gear, the idler shaft is driven by the internal gear. Both shafts carry flywheels which revolve at eight times the main spindle speed and thus possess high momentum. The flywheel of the driving shaft prevents the cutter from "kicking back" as each tool blade bites into the metal, while the auxiliary shaft flywheel prevents the cutter from "jumping ahead" as each tool blade leaves the cutter. In this manner, the two flywheels maintain a neutral action, one set of forces counterbalancing the other so as to give a smooth flow of power direct to the cutter at the periphery.

Pick-off gears are furnished on the face milling head to provide twelve spindle speeds ranging from 6 to 60 revolutions per minute. The "Broadside" machines have the usual eighteen feed changes of the regular Simplex and Duplex machines, either through pick-off gears or a quick-change gear-box. Tables 14 or 22 inches wide, with longitudinal feeds ranging from 3 to 11 feet, can be furnished. Patents have been applied for on these machines.

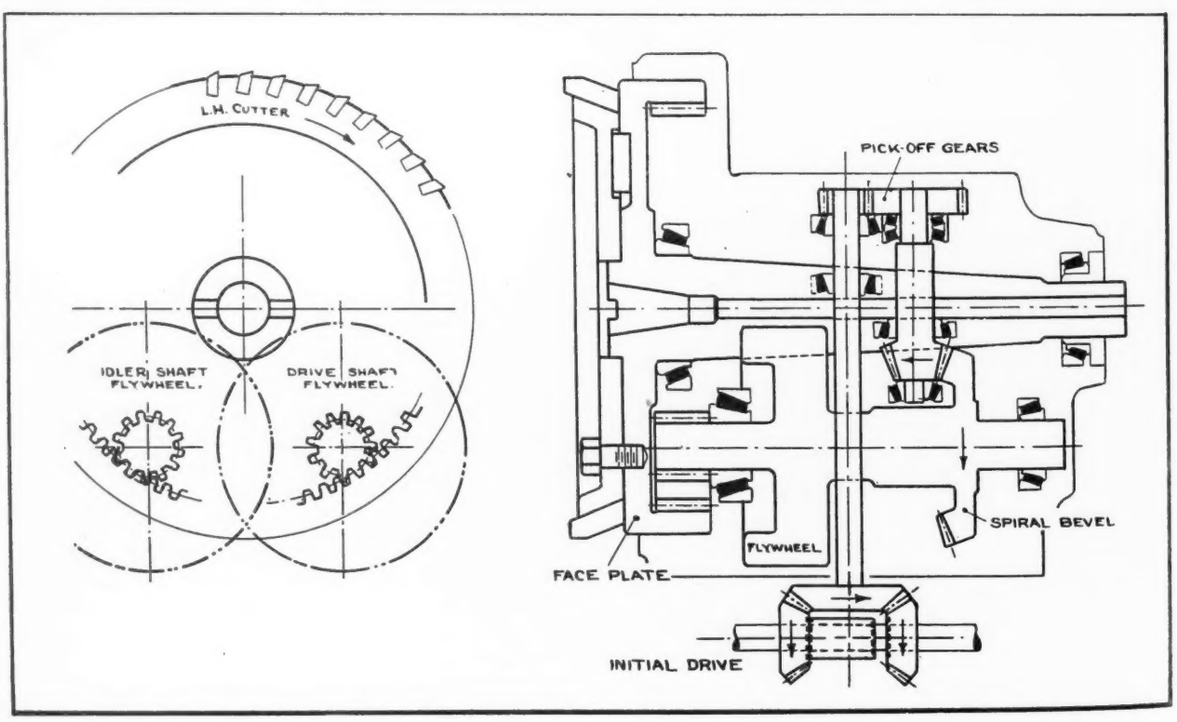


Fig. 2. Diagram Illustrating the Drive to the Cutter on the Face Milling Head of "Broadside" Milling Machines

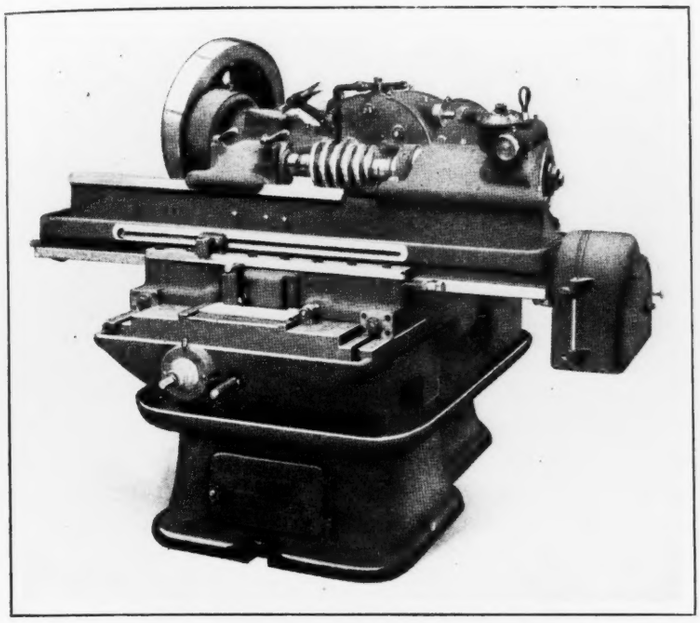


Fig. 1. Pfauter Automatic Worm and Thread Milling Machine

PFAUTER AUTOMATIC WORM AND THREAD MILLING MACHINES

Two Pfauter automatic worm and thread milling machines, with capacity for machining worms up to 9 7/8 and 11 13/16 inches maximum diameter, respectively, are being introduced on the American market by O. Zernickow Co., 21 Park Row, New York City. The minimum diameter to which the worm root can be cut on either machine is 9/16 inch. The smaller machine has a net weight of 3860 pounds, and the larger machine, 6060 pounds.

The cutter-head of these machines is mounted on a base which swivels in a vertical plane on the upright. Swiveling of the cutter-head is effected through a worm mechanism by loosening the swivel base bolts, a graduated scale being provided to insure accurate settings. The cutter-head must always be so swiveled that the cutter axis is at right angles to the line of the thread, or, in other words, it must be inclined from the horizontal the amount of the helix angle. The cutter-spindle is adjustable axially, and its main bearing, radially.

A feature of the design is that by placing the cutter-spindle at an inclination of 10 degrees to the axis of the work, in the horizontal plane, large driving gears can be employed with a minimum cutter diameter, and a heavy flywheel can be mounted on the intermediate shaft. The construction is shown in Fig. 2. In mounting the cutters, the correct axial position is obtained by means of a setting gage which is held on a swiveling arm. This gage is placed over the cutter, and the latter positioned axially by means of spacing collars until the gage fits the cutter properly.

The work is mounted either between centers, on arbors, in special collets, or in bushings having a differential locking nut. One end of the work is supported by an index-head having a large bore to receive a center, arbor, collet, etc. The index drive consists of a worm-wheel and worm, mounted in a dustproof housing and run in oil. Change-gears are provided to make the work revolve in the correct ratio to the longitudinal movement of the work-table to produce the desired thread lead. In milling multiple threads, indexing from the start of one thread to another is quickly accomplished.

The work-table is inclined toward the cutter-head so as to offer more resistance to the cutting pressure. The table rests on wide vee and flat ways on the cross-slide. On each side of the cross-slide at the front there is a lock-nut for drawing the slide down on its ways and thus fastening it securely to the bed. Change-gears provide for selecting the most suitable feed per revolution of the cutter for every kind of material and size of cutter or work. The feed drive can be disengaged automatically or by hand.

DEFIANCE OPPOSED-HEAD HORIZONTAL REAMING MACHINE

A special two-way horizontal machine recently built by the Defiance Machine Works, Defiance, Ohio, for heavy boring, reaming, drilling, tapping, and other operations on automobile axles or similar work is shown in the accompanying illustration. The base of this machine has heavy broad ways on which the heads slide and which also support the work fixture in the center of the machine. Single- or multiple-spindle heads can be furnished. The spindles run in either anti-friction or bronze bearings. They are driven by stub-tooth heat-treated gears, which are enclosed and continuously oiled by either the splash or force-feed system. The large gears are of the helical type.

The machine can be equipped with an Oilgear feed and pump or with a mechanical feed which provides, first, a rapid power approach to the work; then, any desired rate of feed; next, an automatic

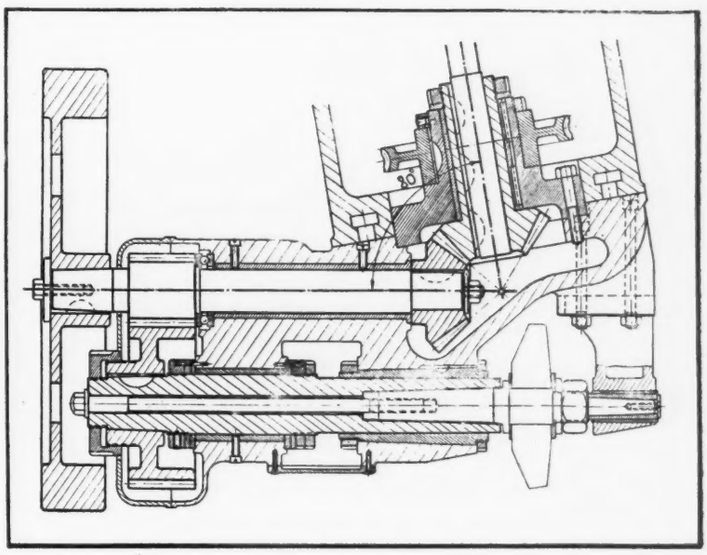
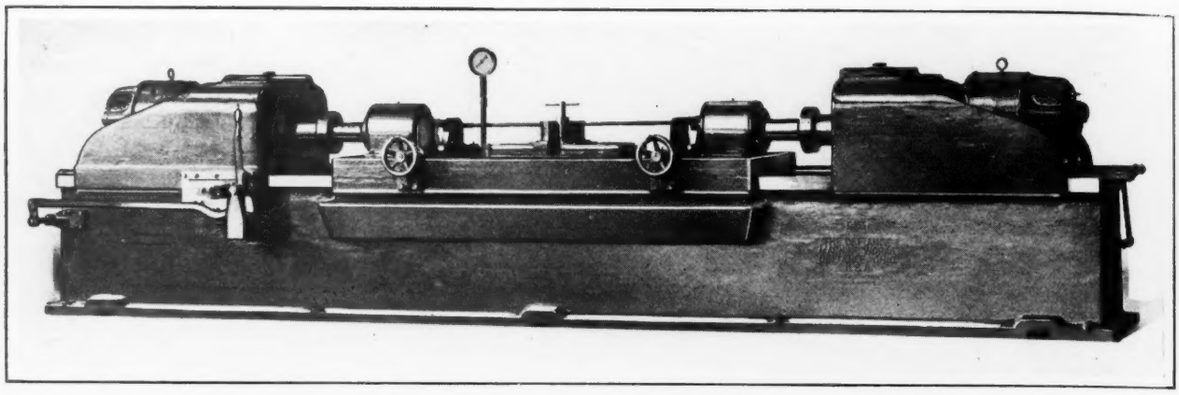


Fig. 2. Section through Cutter-head, Showing Cutter-spindle, Intermediate Shaft, etc.



Defiance Horizontal Machine for Heavy Boring, Reaming, Drilling, Tapping, etc.

kick-off; and, finally, an automatic rapid return. The length of bed, height of spindle centers above the floor, number of spindles in each head, and construction of work fixture are always made to suit the requirements of the work to be done.

The machine illustrated is equipped with an Oilgear feed, an individual motor drive for each head, and an Oilgear pump. The heads are driven by five-horsepower motors running at 1200 revolutions per minute, and a three-horsepower motor running at 900 revolutions per minute is used for driving the Oilgear pump. This machine occupies a floor space of 19 feet by 64 inches, and weighs approximately 18,170 pounds.

DIAMOND CONTINUOUS GRINDING MACHINE

Castings or forgings may be ground from the rough in one operation in a continuous grinding machine recently brought out by the Diamond Machine Co., 9 Codding St., Providence, R. I. This machine differs from standard Diamond face grinding machines in that the reciprocating table is eliminated and a large circular fixture is furnished which revolves to carry the work across the abrasive wheel. Work-holding chucks of different types and sizes are mounted on this fixture to suit the particular work for which the machine is intended. As each chuck is moved to the grinding wheel it is rotated on its own axis for the operation. Individual motors for each chuck are mounted on the rear of the work fixture and revolve with it. After a chuck leaves the grinding wheel, it ceases rotating on its own axis.

The machine here illustrated is equipped with eight pneumatic chucks on the constantly revolving work fixture. During the operation of the machine, three of these chucks are always revolving on their axes, while the five remaining ones are stationary. A brake is provided for stopping the chucks as they leave the grinding wheel after the power that actuates them has been turned off. In Fig. 2 only one of the chucks is shown assembled on the work fixture, but the spindles for the other chucks can be seen projecting from the fixture. The fixture of this machine operates at a speed of one revolution every two minutes.

The work pieces held in the chucks are unclamped automatically as the chucks leave the grinding wheel. Thus, the operator can quickly remove the finished piece and place a new piece in position which, in turn, is automatically clamped in the chuck before it reaches the grinding wheel. Operation of the machine does not require a skilled man, since his task consists largely of merely placing the rough work in the chucks and removing the finished pieces.

The grinding wheel is of the segmental type and is mounted on a spindle which revolves in Timken tapered roller bearings. Machines can be built

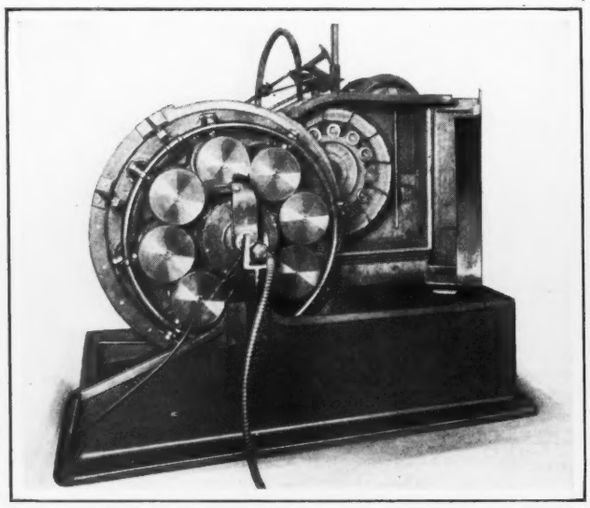


Fig. 1. Diamond Continuous Grinding Machine for Face-grinding Parts Rotated on their Axes as They Move over the Wheel

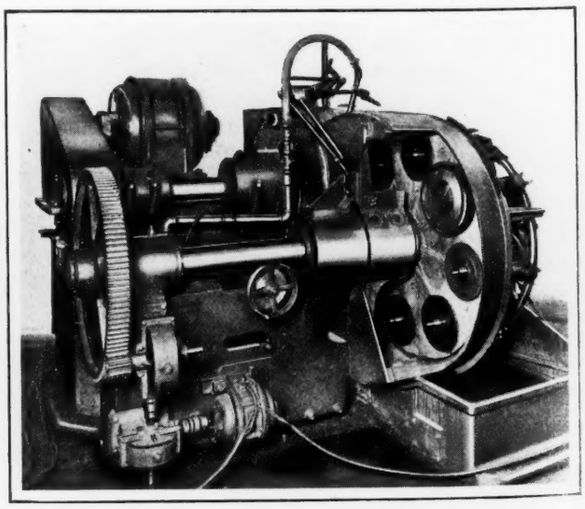


Fig. 2. Another View of the Continuous Grinding Machine, Showing One Chuck Mounted in Place on the Revolving Work Fixture

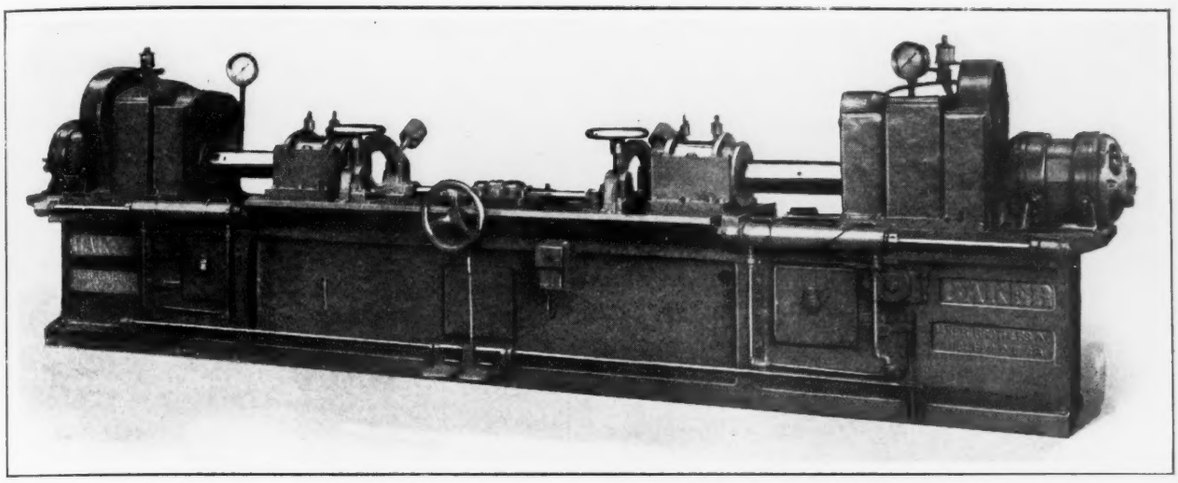


Fig. 1. Baker Hydraulic-feed Horizontal Type Machine Designed for Application to a Wide Range of Work

with 18-, 30-, 36-, 54- and 66-inch wheels, the one here illustrated being furnished with a 30-inch wheel. The grinding wheel is fed forward slightly from time to time to compensate for wear. An indicator arm is usually attached to the machine, so that the operator can gage the thickness of finished pieces and thus be guided in the amount he feeds the wheel forward. The grinding wheel is dressed while in operation, a special truing device being provided for this purpose.

A graduated hand-feed facilitates accurate feeding of the wheel toward the work. The dial is about 8 inches in diameter having graduations spaced 3/8 inch apart, each of which represents 0.0005 inch of wheel movement toward the work.

The wheel-head can be swiveled 1/8 inch each way for making fine adjustments, and the work-head can be swiveled a similar amount in each direction, vertically. With this construction, it is possible to obtain a condition under which the wheel will cut very lightly as it leaves the work, and thereby aid in obtaining a smooth finish. The work fixture is mounted on a spindle equipped with Timken tapered roller bearings.

The machine is completely motor-driven, eleven motors being provided on the particular machine illustrated. The wheel-head of this machine is equipped with a 40-horsepower motor; a 1-horsepower motor is used for driving the work-head; and 3/4-horsepower motors are directly connected to the spindles of the eight chucks. There is also a separate motor for the water pump. The work chucks and motors that drive them are equipped with ball bearings.

The parts of this continuous grinding machine which may be considered essentially standard include the grinding wheel head, grinding wheel, grinding wheel spindle, silent chain drive, wheel-feeding mechanism, coolant system, and wheel-dressing device. These parts are also practically standard on Diamond grinding machines of the reciprocating-table type. The actual grinding time of any part handled by the continuous grinding machine, of course, depends upon various factors, such as the area of the work to be ground, the depth of stock to be removed, and the time required for loading and unloading work.

By using the grinding process for finishing parts, it has been found possible to save a great deal of material, as it is not necessary to grind off as much stock as would have to be taken off by a steel cutting tool, which would have to go considerably below the scale on the work. In some instances, as much as two-thirds of the material formerly converted into chips has been saved in this way. In one case where parts weighing 9 pounds each were ground, the saving was as much as 1 pound of metal per piece or 500 pounds per day.

BAKER HYDRAULIC-FEED HORIZONTAL MACHINE

There has recently been placed on the market by Baker Bros., Inc., Toledo, Ohio, a horizontal type of hydraulic-feed machine which is so built in units that it can be readily adapted to a wide range of operations. The essential units of this No. 25 HH

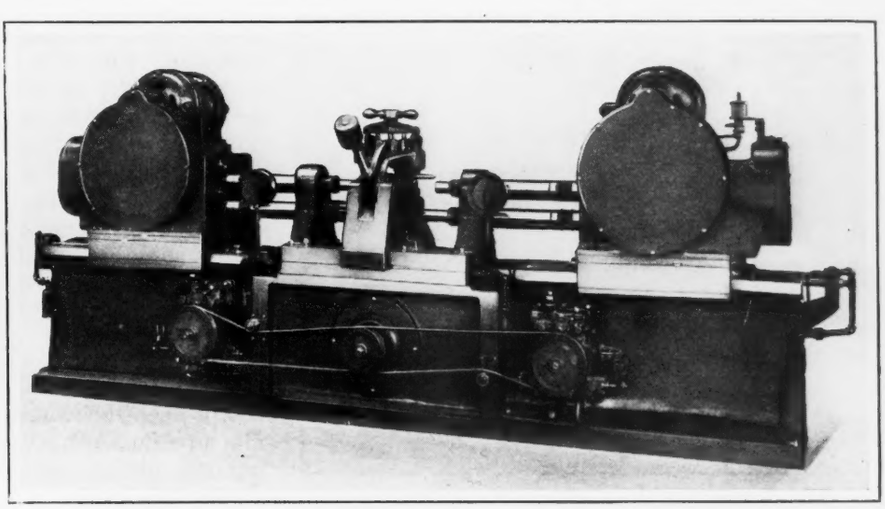


Fig. 2. Rear View of Baker Machine Equipped with Two-spindle Heads

machine are two end frames to which are attached sliding saddles, as shown in the illustrations. Each of these saddles is operated by an independent Oilgear pump. On the saddles are mounted the necessary heads, whether of single- or multiple-spindle design. Between the end frames there is a center frame of the required length to accommodate fixtures for holding the work. The main heads are driven by independent electric motors.

The feed is controlled by foot-pedals located in front of the machine, convenient to the operator. By providing an Oilgear pump at each end, the piping is simplified and a complicated equalizing mechanism is eliminated. The Oilgear mechanisms, of course, give an infinite number of feeding rates and provide an automatic quick return. The saddles slide on wide scraped ways proportioned for maximum alignment and rigidity. There is a pressure gage on each hydraulic pump from which the operator can immediately determine whether working conditions are satisfactory or not. An abnormal pressure would indicate dull tools, undue hardness of the material being machined, or an abnormal condition in chucking or operation.

Fig. 1 shows the front view of a machine provided with single-spindle heads at each end and work-holding equipment for boring and counterboring rear-axle housings for motor trucks. Fig. 2 shows the rear view of a machine having heads fitted with two spindles each, a work fixture, and a boring-bar support for boring holes in automobile transmission cases. One machine thus arranged is used for the roughing operation, and a second similar machine for the finishing operation.

BOWLUS ARC-WELDING MACHINE

An arc-welding machine developed with the plan in mind of combining in one machine a number of standard units that would be applicable to a wide range of welding operations is being introduced to the trade by Claude A. Bowlus, 808 Bates St., Birmingham, Mich. This machine is shown in Fig. 1. In one application, three welding heads are used for simultaneously producing three welds on one piece of work, and in another application, four welding heads are employed.

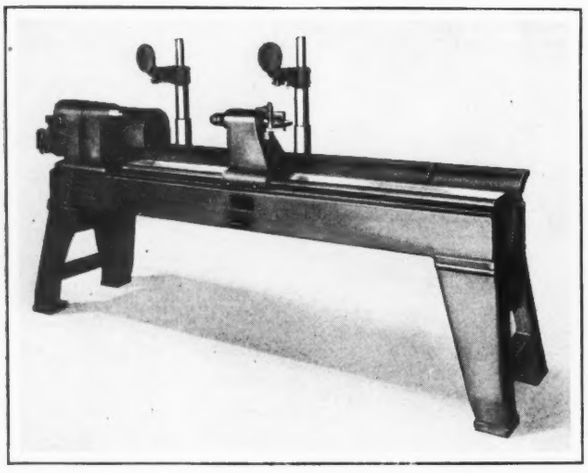


Fig. 1. Bowlus Arc-welding Machine Made up of Standard Units for Ready Adaptation to Individual Jobs

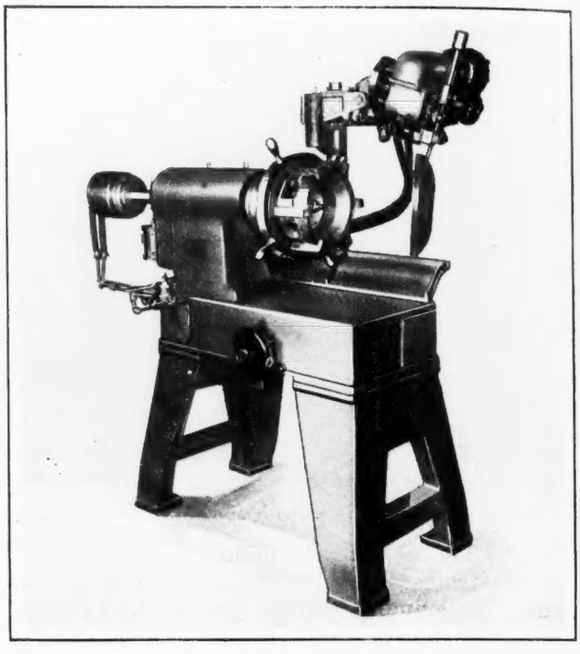


Fig. 2. One Adaptation of the Machine Shown in Fig. 1

The machine has independent rotary and traverse movements derived from separate motors. These movements can be used independently or interlocked with standard arc-welding control panels. The welding-head support is mounted on a motor-driven gear-box which provides two ranges of traverse speed, while the live spindle is driven by another motor. There is a quick-acting tailstock which is adjustable along the ways for holding work of any length up to 60 inches, between centers.

For an annular one-revolution weld, such as is made in welding a tube to a forging, the welding heads would be mounted on the brackets, and these would be adjusted to the positions of the respective welds and then clamped to the slide-rail. A patented registering and limit switch device stops the machine at the end of one operation, and so the operator can busy himself with other minor operations while the welding is in progress. In many cases, one operator tends two machines.

For a seam weld the live-spindle gear-box assembly and the tailstock would be omitted, and the work would be held in a fixture mounted on the bedplate. For such operations as building up armature shafts or building up a shoulder on any cylindrical piece, both the rotary and traverse movements would be used and the patented one-revolution register and stop would not be needed.

Another adaptation of the machine is illustrated in Fig. 2. Here the machine is provided with a heavy spindle, an air-operated chuck, and an air-controlled welding head. There is no tailstock.

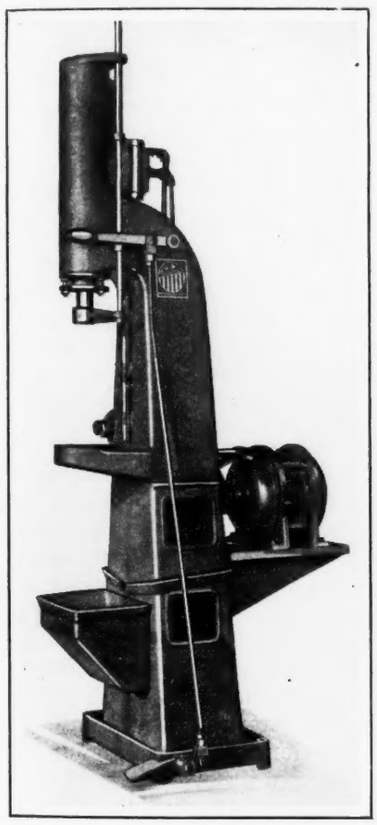
AMERICAN VERTICAL BROACHING PRESS

A two-ton hydraulic press of new design has recently been developed by the American Broach & Machine Co., Ann Arbor, Mich., for various broaching, assembling, push-pressing, arbor-pressing, and similar operations. The machine is self-contained, is equipped with oil-pumps and an oil reservoir,

and can be supplied with either a belt or motor drive. It has a stroke of 14 1/2 inches and a ram diameter of 2 inches. The end of the ram is tapped to receive pushing attachments.

The work-table is bored to 2 3/4 inches central with the ram, and the front is cast with a notch which does not extend into the bore. However, in cases where it is desirable to have this notch reach the bore to facilitate the removal of assembled parts, the remaining metal can be easily cut away to suit. The table surface is 8 inches in diameter, and work up to 10 1/4 inches in diameter can be accommodated.

This machine can be controlled either through a hand-lever or a foot-pedal. It is so arranged that immediately upon release of the pedal or lever, the ram automatically returns to the top or starting position. The up stroke of the ram is approximately 25 per cent faster than the down stroke. A balanced piston valve controls the ram action. The oil reservoir is located in the frame proper and holds approximately five gallons. The pump works at a maximum capacity of 400 pounds per square inch. A direct-reading gage shows the total amount of pressure applied, and the pressure in pounds per square inch.

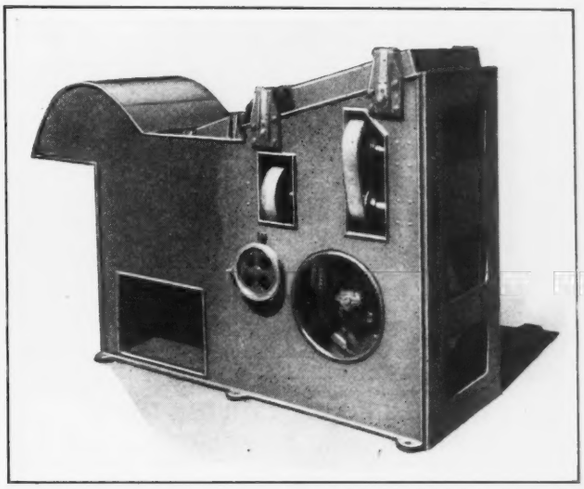


American Hydraulic Broaching Press

This machine can be furnished in a bench type or with a pedestal and floor pan as shown. When the machine is belt-driven and the drive pulley is operated at 600 revolutions per minute, the working speed of the ram is 14 feet per minute. The pulley can be run as fast as 1200 revolutions per minute, which increases the working speed of the ram proportionately. For a motor drive, a two-horsepower motor, running at 1800 revolutions per minute, is used. Equipped with a pedestal, the machine weighs 800 pounds, while the bench type weighs 580 pounds.

MC KENZIE SEPARATOR FOR SCREW MACHINE PRODUCTS AND CHIPS

An improved "Model 1928" machine for separating parts produced in screw machines from their chips is being introduced on the market by the McKenzie Engineering Co., P. O. Box 519, New Rochelle, N. Y. Two important improvements in this equipment, which is here illustrated, are a lower design, which facilitates loading, and an automatic feed which carries the material into the vibrator and saves the time of the operator. The vibrator is made of material 1/8 inch thick, and the feeder mechanism of 3/16-inch sheet steel. A blast gate is combined with the blower, the amount of air being regulated by a graduated handwheel.

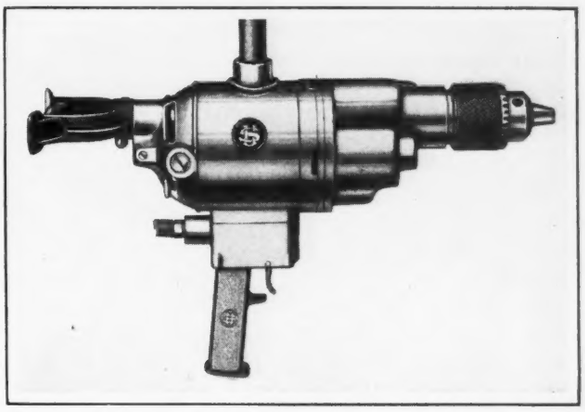


McKenzie Separator for Screw Machine Products and Chips

Parts from 1/8 to 2 1/2 inches in diameter and up to 4 1/2 inches in length can be separated, less than one minute being required for handling a bushel of the average run of screw machine products. All the operator does is to load the chips and work into the receiving box from a pan which comes from an oil extractor, and then regulate the air blast to suit the size of the parts to be separated. The machine feeds the material into the vibrator, spreads it, shakes the parts loose, blows the chips into a box or barrel at the rear, and lets the finished parts fall from the air chamber into a separate box. The machine measures 5 1/2 feet by 40 inches by 21 inches.

U. S. PORTABLE ELECTRIC DRILL

A low-speed 3/4-inch drill, designed for continuous heavy-duty service, has been added to the line of portable electric devices manufactured by

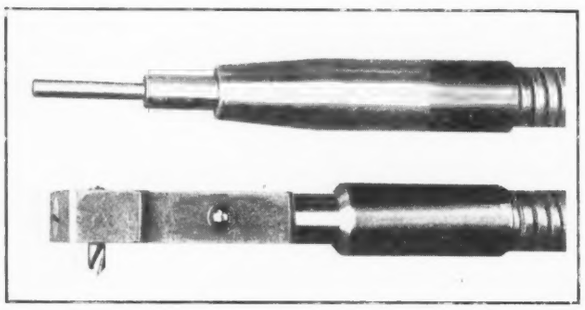


Heavy-duty 3/4-inch Drill Made by the United States Electrical Tool Co.

the United States Electrical Tool Co., 2477 W. 6th St., Cincinnati, Ohio. This tool is equipped with a universal motor which operates on alternating or direct current, and drives the drill at a load speed of 350 revolutions per minute. In all other respects, the drill is typical of other drills made by the company. It is equipped with S K F ball bearings; chrome-nickel steel gears, which are hardened and run in grease; a one-piece aluminum body frame and commutator head; a quick make-and-break two-pole trigger switch; and a three-jaw screw-back chuck for straight-shank drill bits, etc. This new model weighs 27 pounds.

MIDGET CLOSE-QUARTER DRILL

A right-angle drilling device intended for use in drilling holes located in close quarters is being placed on the market in several sizes by Charles A. Koza, 464 Augustine St., Rochester, N. Y. This drilling device receives power through a flexible shaft. Attached to one end of the flexible shaft, as shown in the upper view of the illustration, is a member carrying a bearing through which runs a solid shaft that is an extension of the flexible shaft. This extension can be held in an ordinary drill



Right-angle Drilling Device Intended for Use in Close Quarters

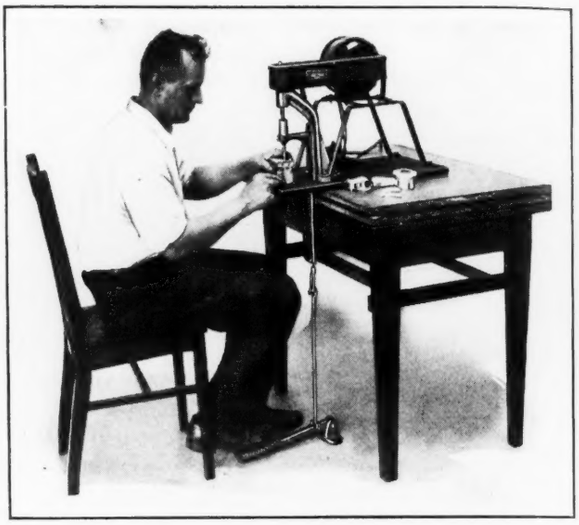
chuck mounted on any machine spindle and power can be transmitted through it to the flexible shaft and then to the main body of the tool.

In the smallest size, this drilling device is only 7/8 inch wide and can, therefore, be employed in a space 1 inch or more high. Holes may be drilled within 5/8 inch of a shoulder. Drills up to 1/4 inch in diameter may be employed in this size device for drilling in metal, wood, etc. The device may be driven by a 1/4-inch portable electric drill. Three larger sizes take drills up to 1 inch, inclusive.

This drilling device has been found particularly useful in building airplanes, because of the many close-quarter places about the framework and pontoons in which holes must be drilled.

VIM SCREW-DRIVING AND NUT-SETTING MACHINES

Motor-driven bench machines that are intended for screw-driving, nut-setting, drilling, grinding, buffing, and similar operations are being placed on the market in several types by the Vim Tool Co., 149 Broadway, New York City. The illustration shows a type C machine arranged for foot operation, leaving the operator's hands free for the work. This machine can be made with a throat



Vim Bench Machine for Screw-driving, Nut-setting, etc.

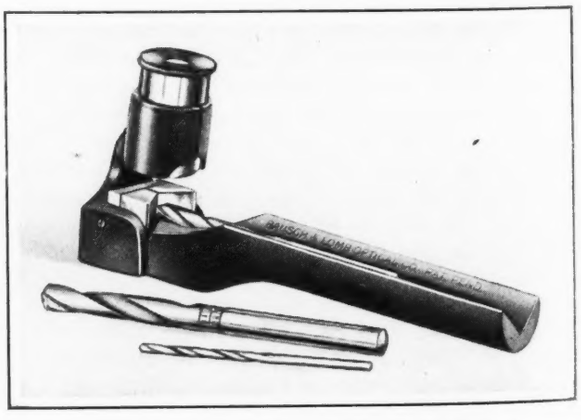
depth varying from 3 3/8 to 6 inches. Wood and metal screws up to No. 10 can be driven with a bit speed of 1000 revolutions per minute.

One of the features of these machines is that the bits do not revolve until the work is applied to them, the tool-holder or hand-piece being equipped with a clutch which engages automatically at that time. Several of these machines can be arranged in a battery and driven by one motor.

BAUSCH & LOMB OPTICAL DRILL GAGE

An optical drill gage is manufactured by the Bausch & Lomb Optical Co., 662 St. Paul St., Rochester, N. Y., by means of which drills can be checked (a) to determine the location of the point or apex in relation to the axis of the drill; (b) to see if the cutting lips are inclined at the same angle relative to the drill axis; and (c) to determine whether the web is central relative to the drill axis.

In checking a drill to determine the location of its point or apex in relation to the axis, the drill is placed in the long V-shaped groove of the gage, as illustrated, and pushed forward until the point is almost in contact with the profile gage, which is located under the magnifier. The drill is then rotated until the apex is parallel to the line of sight through the center of the magnifier. The magnifier is next focussed on the drill by sliding the former in or out of its supporting sleeve. If the point of



Bausch & Lomb Optical Gage for Checking Drills

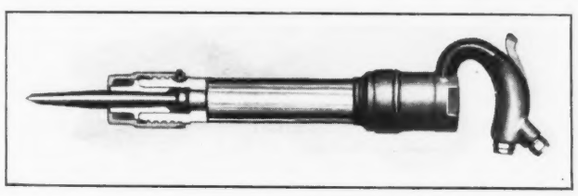
the drill is exactly true with the axis, it will be central in the narrow slit formed by the parallel adjacent sides of the gage-blocks. This slit is 0.002 inch wide, and serves as a basis for estimating the amount that drill points are off center.

In checking the angle of the cutting lips, the drill is held in the V-shaped groove in the same manner. When the drill is again pushed against the gage-blocks, any difference in the angle of the cutting lips or in their length will be revealed by lack of contact with the gage surfaces. The deviation appears doubled when seen through the magnifier.

For checking the web position relative to the drill axis, the drill is held in the V-groove with the point or apex at right angles to the line of sight. The corners formed by the apex and web then touch the two gage-blocks if the web is central. Any amount of off center is indicated by the contact of one point only. This gage is intended for checking drills up to 3/4 inch.

INGERSOLL-RAND "RIVET BUSTER"

A size 999 pneumatic hammer known by the trade name "Rivet Buster" has been developed by the Ingersoll-Rand Co., 11 Broadway, New York City, for cutting or breaking off rivet heads up to



Ingersoll-Rand Pneumatic Hammer for Removing Rivets

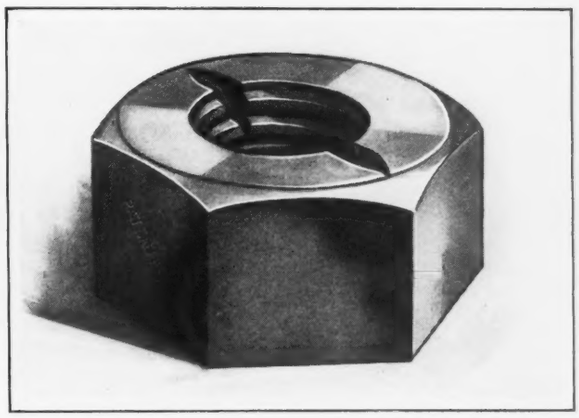
3/4 inch and for knocking the rivets out. This device is light enough to be handled by one man.

The nozzle end is fitted with a heavy square-section thread over which a retainer nut is screwed as illustrated. This nut takes the blow of the hammer through a rubber buffer when the device is operated without the cutting tool being held against the work. On the upper end of the taper-shank tools used, there is a knob which permits the use of light weight tools. This knob furnishes a shoulder for transmitting the blow through a split nozzle to the rubber buffer and on to the retainer nut, when the hammer is operated without a tool being held against the work. With this construction, the tool cannot be "shot" out of the hammer.

Three different tools are furnished for use in this "Rivet Buster"—a No. 205 cutting chisel, a No. 204 shearing chisel, and a No. 206 knock-out punch.

COLE GRIP-NUT

A one-piece grip-nut designed to hold without the use of lock washers, double locking nuts, or other holding devices has been placed on the market by W. B. Spencer, 25 Broad St., New York City. This Cole grip-nut maintains its hold through the elasticity or "spring" inherent in metal. It is screwed down on the bolt in the ordinary manner without difficulty, but the natural springiness of the solid metal reacts through the slotted nut-head so as to



Cole Nut with Self-gripping Feature

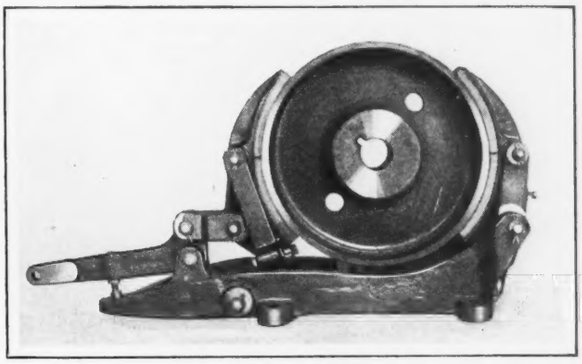
give a gripping action on the bolt that interferes with removal.

In its manufacture, the blank nut is first slotted as shown, which causes it to expand about 0.004 inch on the sides at the slotted end. It is then threaded in the usual manner, except that the top threads from the slot to the face of the nut are not of full depth, due to the expansion that takes place in the slotting operation.

After being threaded, the nut is put under a press and pressed together about 0.009 inch, so as to make the top face of the nut about 0.005 inch narrower for the depth of the slot, than the remainder of the nut. Therefore, when the full thread of the bolt comes in contact with the threaded portion at the slot, it meets a springy resistance in the nut itself. This resistance is said to overcome vibration and hold the nut firmly.

MECHANICALLY OPERATED BRAKE FOR CRANES AND HOISTS

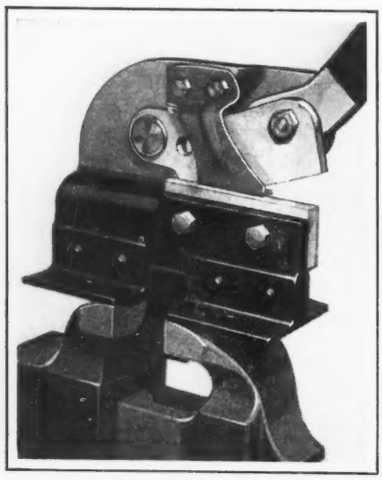
A type WB mechanically operated brake intended for use in the bridge drives of electric traveling cranes, electric hoists, and other equipment requiring foot- or hand-lever operated brakes, is a recent development of the Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland, Ohio. This device is of the shoe type, as shown, and is a modification of the type WB electrically operated brake. Practically all the wearing parts of the mechanically operated device are interchangeable with similar parts of the electric brake. Molded asbestos shoes of unusual thickness are provided.



Mechanically Operated Brake Made by the Electric Controller & Mfg. Co.

NATIONAL VISE SHEAR

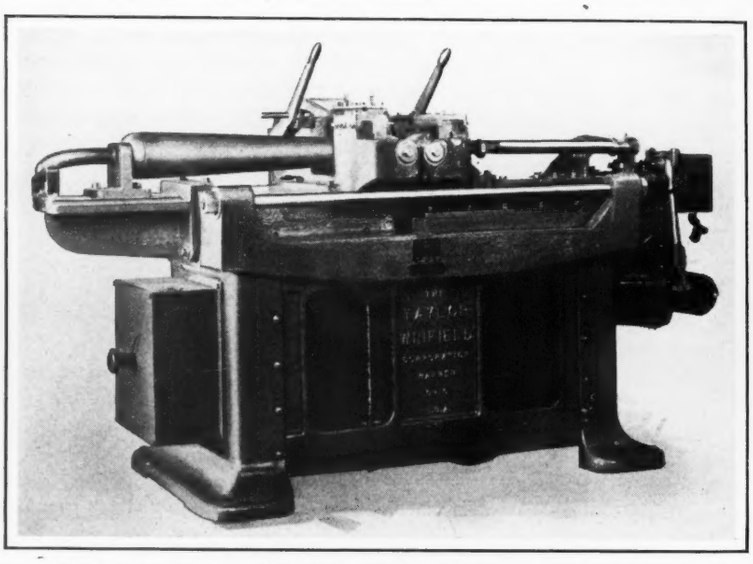
A portable slitting shear, which may be quickly mounted in a bench vise as illustrated, is manufactured by the National Machine Tool Co., 1536 Clark St., Racine, Wis. The shear can be held in vises either lengthwise or crosswise. It can also be conveniently mounted on a bench, when desired, by swinging the tapered latch upward out of the way. The tool-steel blades provided can be easily removed for sharpening. This shear has a capacity for 1/8-inch sheet metal and 3/16-by 2-inch flat bars. The body design permits of readily slitting wide sheets. A 5/16-inch rod cutter is also embodied in the shear. The weight of the tool is 15 pounds.



Slitting Shear which can be Easily Mounted in Vises

TAYLOR-WINFIELD BUTT WELDER FOR AUTOMOBILE MUFFLERS

A special butt-welding machine developed by the Taylor-Winfield Corporation, Warren, Ohio, for use in the fabrication of automobile mufflers, is shown in the accompanying illustration. This type B-11 machine is motor-driven and provides for uniform, accurate welding. The timing of the current and the upsetting of the weld are accomplished by means of adjustable cams. The cams eliminate the human element entirely from the operation and permit it to be performed with less expensive labor. On the particular job shown, the heads of the muffler are welded to the body, and the intake and outlet tubes are welded to the heads. This makes a completely electrically welded muffler.

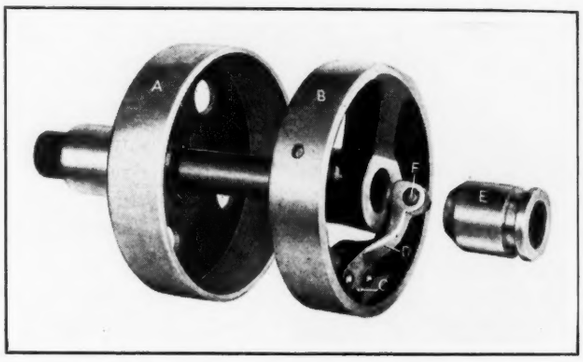


Taylor-Winfield Butt-welder Designed for Welding Automobile Mufflers

EBERLING FRICTION CLUTCHES

Heavy-duty friction clutches made up of but five parts are being introduced on the market by the Eberling Machine Sales Co., 2394 Canal Road, Cleveland, Ohio. From the disassembled view here shown, it will be seen that each clutch has an outer bell or drum *A* which carries an extended sleeve on which the driving pulley, gear, or sprocket may be mounted. For transmitting power through the clutch, the friction ring *B*, which is assembled in the drum, is expanded into firm contact against the inside of the drum rim.

This friction ring is split on one side, and it is expanded by operating roller *C* against an inclined surface of a lug on the inside of ring *B*. The roller is mounted in bracket *D* which swivels on a stud fastened to the friction ring on the opposite side of the split from the point of roller contact. Bracket



Eberling Friction Clutch Disassembled to Show Small Number of Parts

D is swiveled to tighten or release the roller as cone *E* is shifted back and forth on the same shaft as that on which the friction ring is mounted. Cone *E* abuts against the hardened ball-end of adjusting screw *F*, which is contained in a tapped hole in bracket *D*. This adjusting screw provides a means of increasing or decreasing the gripping pressure of ring *B* against the rim of drum *A*, and also compensates for wear of these mating parts.

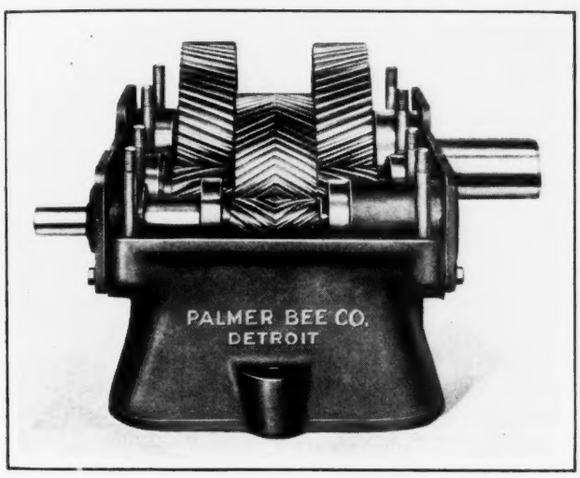
When expanded, ring *B* grips the drum firmly around its entire circumference, with the exception of a few inches diametrically opposite the split. This feature is obtained by boring the friction ring about 0.010 inch off center in relation to the drum. The action in picking up loads is quick and positive, both friction surfaces of the clutch being of cast iron. It is stated that one of these clutches, having friction surfaces 12 inches in diameter by 3 inches face width, picks up a peak load of 3000 pounds from zero, forty-five times a minute. This clutch has a rating of 5 horsepower and has been in operation about three years.

Clutches can also be furnished with a cast-on pulley, which is particularly recommended by the manufacturer for use on lineshafts, countershafts, and machines where single or double units are desired. The clutch is also made as a cut-off coupling for con-

necting two sections of shafting in such a manner that one section can be started or stopped at will while the other runs continuously. Various sizes of clutches are made from 1 horsepower upward to meet requirements.

PALMER-BEE SPEED REDUCERS

In a new line of herringbone-gear speed reducers now being introduced to the trade by the Palmer-Bee Co., Detroit, Mich., anti-friction bearings are used throughout. In the single series reducers, Timken tapered roller bearings are used exclusively, while in the double and triple series, ball bearings are used on high-speed shafts, Hyatt roller bearings on intermediate shafts, and Timken tapered roller bearings on slow-speed shafts. The shafts and bearings are made large enough to take care of overhung loads up to the maximum capacity of the reducers without the use of outboard bearings, as required with former designs.



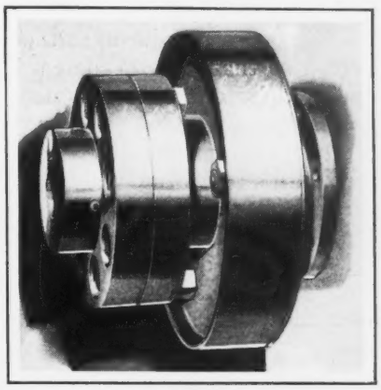
Palmer-Bee Herringbone-gear Speed Reducer of New Design

The single series reducers, as their name implies, have one pair of Sykes continuous-tooth herringbone gears. In double and triple series, the high-speed gears are of the same type, while the slow-speed gears are of the helical type and are arranged in pairs on each side of the reducer. This gives a symmetrical arrangement of the gearing and an equal distribution of the load on each bearing. These speed reducers can also be furnished exclusively with helical gears.

A small amount of oil suffices for lubricating the reducers over a long period of time, as the oil automatically returns to the reservoir at the bottom of the housing after being used. The housing is designed to be bolted to a sub-base by the three-point method.

JAMES AUTOMATIC BACK-STOP AND COUPLING

A combination automatic back-stop and flexible coupling designed for use on elevators, conveyors, and other equipment where there is a likelihood of reversal of travel when the equipment is not running, has been introduced on the market by the D. O. James Mfg. Co., 1120 W. Monroe St., Chicago, Ill. This unit consists simply of a drum-shaped housing, integral with which is one-half a flexible coupling. This half coupling contains free-flexing live rubber bumpers, and several Bound Brook oilless bushings. Another half coupling fitted with hardened and ground steel pins which float inside of the graphite-impregnated bronze bushings, a ratchet plate, three pawls with studs, springs, and fastening bolts, and a two-piece cover plate complete the unit.

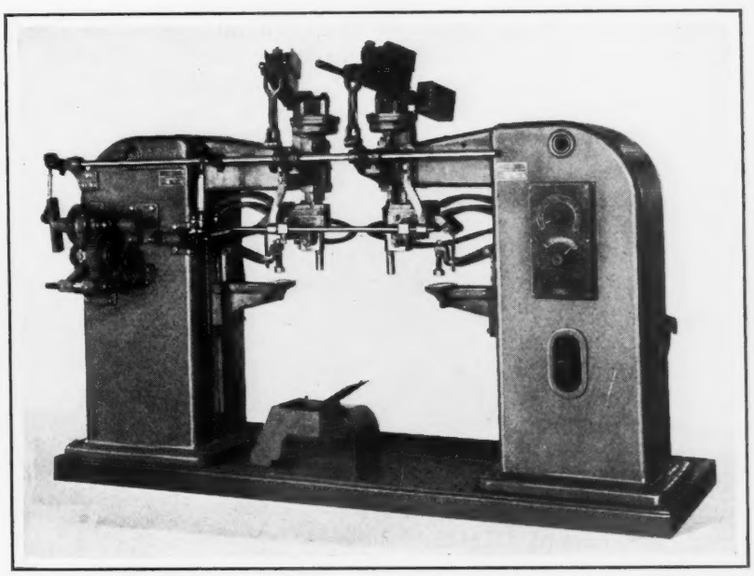


James Combination Back-stop and Flexible Coupling which Prevents Reversal of Equipment

This device is applied to drive-shafts between a speed reducer and the motor. A flange which is attached to the speed reducer housing is cast integral with the ratchet. This ratchet operates within the drum housing which, in turn, is connected through the motor shaft to the coupling. To the inner face of the housing, the three pawls are fastened. Centrifugal force keeps the pawls out of engagement with the ratchet during operation, but should anything happen to the shaft or motor, or should the motor be purposely shut off so as to stop the driven unit, the pawls would engage the ratchet through gravity and provide a brake against reversal of the equipment.

THOMSON DUPLEX SPOT-WELDER

Two rows of spot welds are made simultaneously with a spot-welding machine recently constructed



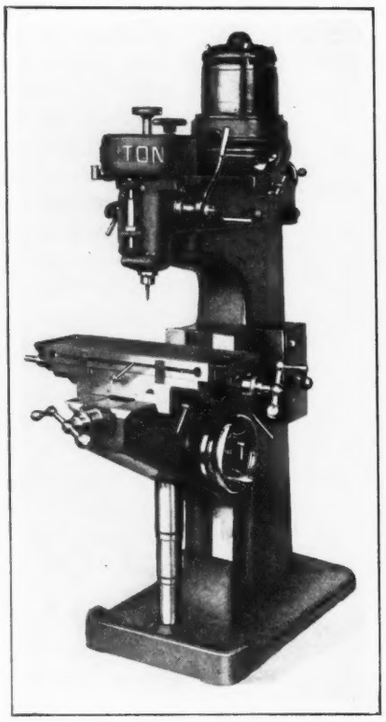
Thomson Welding Machine which Makes Two Rows of Welds at One Time

by the Thomson Electric Welding Co., Lynn, Mass. As may be seen from the illustration, this equipment really comprises two standard heavy-duty welders, which are intended to be mounted face to face on a sub-base and connected so that both heads can be operated by one motor, which is not shown.

This equipment is especially adapted for welding the vertical side members of steel door frames to the top and bottom cross-members. These door frames vary from approximately 2 to 4 feet in over-all width and are made of No. 22 gage material.

The equipment is designed to operate at the rate of 100 spot welds per minute. It is intended that the welders be so arranged on the sub-base that they may be adjusted to suit different widths of doors. A special carriage and a work-table mounted on wheels so that it can be run on a track are to be supplied by the user. This carriage will be so tied up with the driving mechanism that after making one row of three spot welds, the entire door frame will be moved 3/4 inch, and another row of three welds made and so on. Shifting of the upper die points to make the three welds is accomplished automatically through a special drive unit.

A mandrel attached to the carriage for use inside the door members will also be supplied by the customer. A spring-pressure arm, controlled automatically by the drive mechanism, will be employed for clamping the door members firmly against this mandrel to insure locking them in the proper position during the welding operations.



Gorton Vertical Routing and Milling Machine

GORTON MILLING AND ROUTING MACHINE

The latest addition to the line of die-sinking and engraving machines made by the George Gorton Machine Co., Racine, Wis., is a No. 8-D vertical milling and routing machine. This machine is especially adapted for die- and tool-room work and similar milling and routing in brass, steel, and cast iron. It is designed to operate small cutters at high speeds for handling the class of work commonly performed on large plain milling machines equipped with high-speed attachments. The machine will drive a 1/2-inch diameter high-speed steel cutter to the limit.

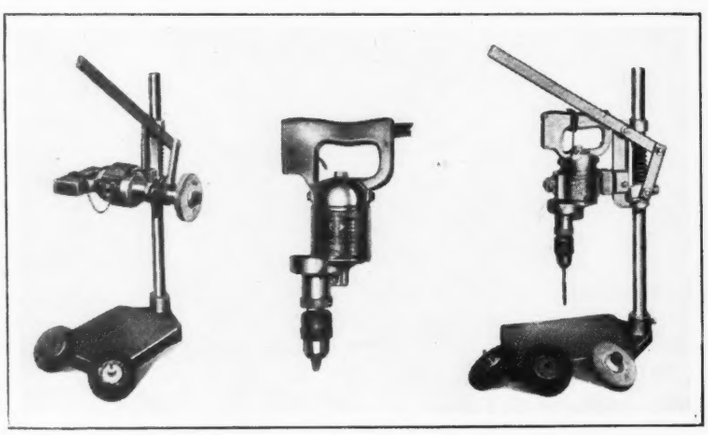
A feature of this equipment is the sliding head unit which carries the spindle and its drive complete. The minimum distance of the spindle from the column is 15 inches, while with the head fully extended, the gap is 30 inches. This gives an area of 15 by 22 inches covered by table movement with one setting of the work. The machine will swing a plate 60 inches in diameter by 4 inches thick or a cylinder 22 inches in diameter by 15 inches high. The maximum distance from the spindle nose to the table is 15 inches.

Power is delivered to the spindle through a V-belt from a 3/4-horsepower ball-bearing vertical type motor. Ten spindle speeds ranging from 475 to 3000 revolutions per minute are obtainable without back-gears or change pulleys. Higher speeds up to 6000 revolutions per minute are available for brass routing and for using diamond tools. For brass routing, the machine is also equipped with a foot-treadle to control the spindle feed, a chip blower which is integral with the motor, and a forming attachment for cutting curved surfaces.

Graduated dials permit accurate adjustment of all feed-screws to fractions of 0.001 inch. The spindle is mounted in a hardened and ground sleeve which slides in a hardened and ground bushing. These two parts can be quickly replaced at any time to maintain the accuracy of the spindle assembly.

WODACK GENERAL-PURPOSE TOOL

A 3/8-inch portable electric drill, which may also be used for odd grinding and buffing jobs, has been added to the line of products manufactured by the Wodack Electric Tool Corporation, 4627-29 W. Huron St., Chicago, Ill. The construction of this drill may be seen in the central view of the accompanying illustration. At the left, it is shown mounted horizontally on a stand and equipped with a grinding wheel. At the right, it is mounted vertically on a stand. The tool is very light weighing only 7 1/2 pounds. It is equipped with a universal motor of the variable-speed type, and is controlled by a trigger switch.



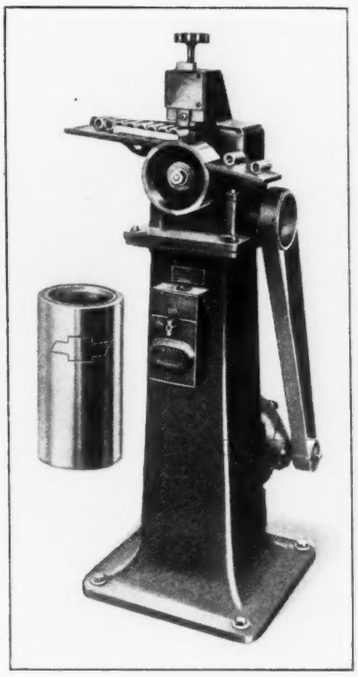
Wodack General-purpose Tool and Two Applications

NOBLE & WESTBROOK MARKING MACHINE

Cylindrical parts, such as piston-pins, sockets for automobile wrenches, studs and bushings, of various diameters and lengths, can be marked in an improved No. 19 "Rapid Production" marking machine recently brought out by the Noble & Westbrook Mfg. Co., Hartford, Conn. This machine is self-contained, being driven by a 1/2-horsepower motor mounted on the column. A loading platform and an apron which takes the work from the machine are two features. Power is applied to the feed-roll through worm-gearing which runs in oil.

The only requirement of the operator is to place parts on the inclined chute. The parts are then automatically carried to the marking die, and after being marked roll into a receptacle. The marking die consists of a steel stamp attached to the face of a small vertical slide. This stamp is adjustable to suit the work diameter, and to make impressions lighter or heavier, by a handwheel at the top of the machine. It is locked in position by a binding screw. The face is concave to conform with the surfaces being marked.

The machine illustrated has a capacity for round pieces up to 1 1/4 inches in diameter. Parts of larger diameters can be handled by substituting other feed-rolls, and longer pieces by adjusting the outer retaining disk away from the feed-roll. The machine gives a production of 100 pieces or more per minute, and weighs 450 pounds.



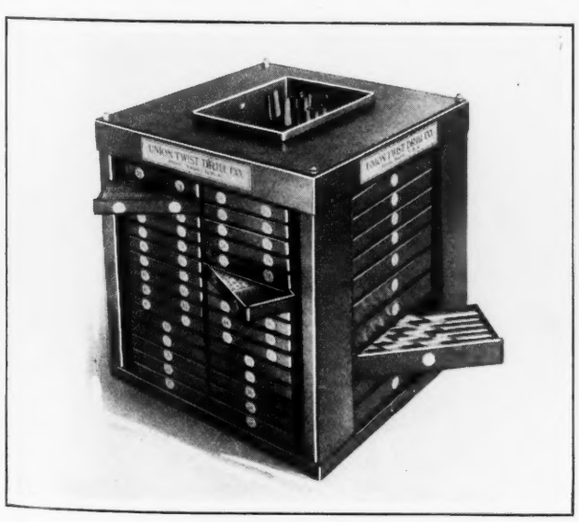
Noble & Westbrook Machine for Marking Cylindrical Parts

UNION DRILL CASE

Storing of drills in the tool-room or shop may be efficiently and easily accomplished by means of a case which has been placed on the market by the Union Twist Drill Co., Athol, Mass. This case is made of sheet steel and has a large number of drawers, as illustrated, which swing on one corner. The drawers may be readily pulled out so that all the contents can be observed, but they cannot be dropped on the floor and spilled or put in wrong places.

Two sides of the case have drawers for wire size drills from No. 1 to 80, inclusive. On the other two sides are drawers for jobber's drills ranging from 1/32 to 1/2 inch, by sixty-fourths of an inch. Bit stock drills may be kept in the top of the case, a cover being furnished for the opening seen in the illustration. Each drawer is marked by a non-corroding two-color metal plate which has the size of drills for which the drawer is intended stamped on it in legible figures.

The case rotates on a substantial base, is less than 14 inches high, and is 12 inches wide on each side. It has a net weight of 38 pounds.

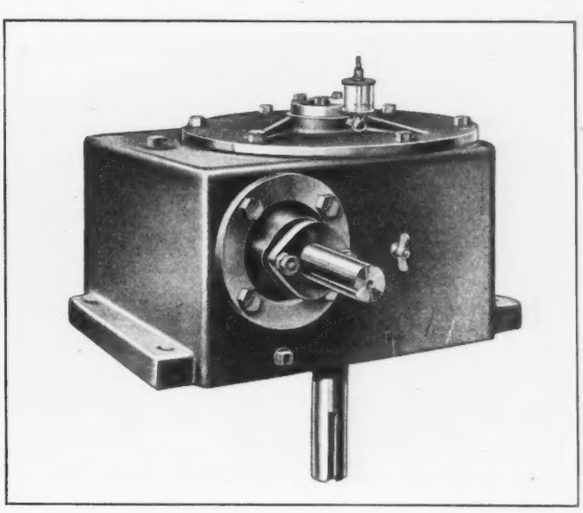


Case Made by the Union Twist Drill Co. for Storing Drills

JAMES VERTICAL-TYPE WORM-GEAR SPEED REDUCER

An improved heavy-duty worm-gear speed reducer made to permit vertical driving of equipment by a shaft projecting either from the top or bottom of the reducer constitutes the latest addition to the line of products made by the D. O. James Mfg. Co., 1120 W. Monroe St., Chicago, Ill. The housing of this reducer is made with a large oil-cooling and heat-radiating chamber. Timken bearings support both sides of the gear shaft, while the worm shaft is mounted on double Timken bearings on one side, and on Norma-Hoffman roller bearings on the other. This bearing arrangement absorbs radial and end thrust loads, eliminates excessive heating, and reduces wear of the worm and gear.

The gear shafts are ground to size and made to withstand emergency strains and starting loads. The worms are made integral with their shafts. The gears are made of phosphor-bronze, the larger



James Worm-gear Speed Reducer of Vertical Type

sizes being made up of a bronze ring which is shrunk on and keyed to a cast-iron spider. Teeth having a pressure angle of from 20 to 30 degrees are standard.

AMES AMPLIFYING COMPARATOR

An amplifying comparator provided with a diamond measuring point is a recent product of the B. C. Ames Co., Waltham, Mass. This comparator is also equipped with a fan-shaped indicator on which the pointer moves nearly 3/16 inch for each 0.0001 inch movement of the diamond measuring point. For a 0.001 inch movement of the measuring point, the indicator pointer moves nearly 1 1/2 inches. The device is intended for comparing measurements of round, flat, or odd-shaped parts with known standards. In the illustration it is shown being used for testing pistons on which limits of 0.0005 inch are specified.

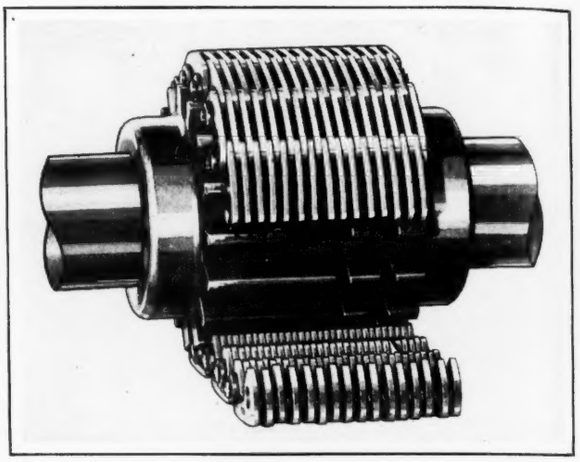
Ames Amplifying Comparator with Diamond Measuring Point

In setting the comparator, a standard size block or unit is placed on the platen directly under the measuring point. The dial is then adjusted to bring the pointer to zero, after which the size-block is moved away from the measuring point and returned several times to make certain of the adjustment. The work to be tested is then brought directly under the measuring point. The dial pointer moves to the left of zero to indicate a minus dimension and to the right of zero to indicate plus dimensions. Minus graduations are red, while plus graduations are black. Size variations to 0.000025 inch can easily be detected.

The platen may be clamped in different positions to compensate for wear. It is mounted on an adjustable spindle. V-blocks and special shapes and sizes of platens can be supplied. The amplifying comparator illustrated has a measuring capacity of 8 inches, is 16 inches high over-all, and weighs 70 pounds.

MORSE FLEXIBLE COUPLING

A flexible coupling which consists primarily of a Morse chain wrapped around two sprockets, each of which is one-half the width of the chain, is a recent product of the Morse Chain Co., Ithaca, N. Y. One of the sprockets has a guide groove in the center of the face to hold the chain in place, while the other is without a guide groove and is free to float under the chain. The accompanying illustration shows the construction. The chain fits loosely enough on the sprockets to take care of ordinary shaft misalignment and lack of parallelism.

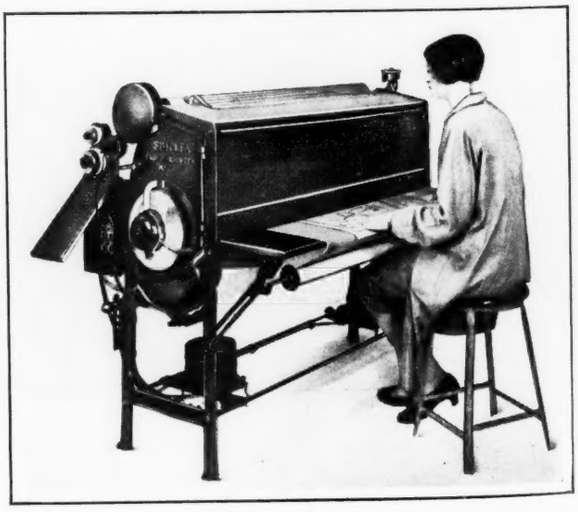


Morse Flexible Coupling Made up of Two Sprockets and a Chain

SHAW CONTINUOUS HORIZONTAL BLUEPRINT MACHINE

A blueprint making machine of continuous type, designed primarily for the smaller user of blueprints, has recently been brought out by the Shaw Blue Print Machine Co., Inc., 9-11 Campbell St., Newark, N. J. One of the features of the equipment is its simple construction, which enables anyone to learn to operate it quickly. Essentially the machine consists of a half cylinder of plate glass, mounted in cradles on end castings. Around this glass half cylinder there passes an endless canvas band. A flaming arc lamp suspended from a steel grooved worm operates back and forth across the machine. A motor mounted in the frame furnishes power through friction disks for driving the canvas band and the lamp in a synchronized movement, from one drive shaft. A small ventilator fan cools the lamp, the latter being easily accessible for renewing carbons.

Prints up to 42 inches in width and of any desired length can be made in this machine. Sixteen

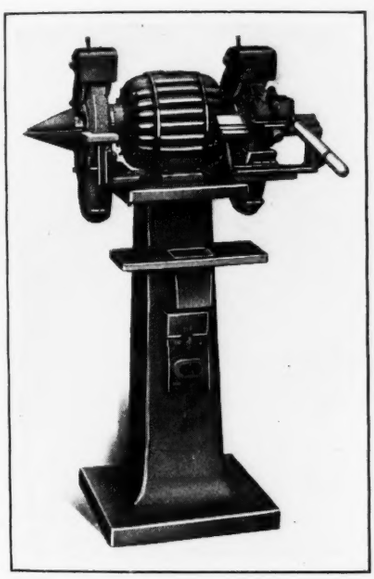


Shaw Continuous Blueprint Machine of Horizontal Design

speeds, ranging from 4 inches to 4 feet per minute, as required for various types of tracings and prints, are immediately obtainable by setting a numbered dial at the top of the machine on the right-hand side. Tracings and sensitized paper, either from a continuous roll or precut to the tracing size, are fed into the front of the machine from the feeding table. The tracings return to the operator at the top of the machine, while the prints go to the receiving table at the rear. Blueprints, negative prints, prints with blue or brown lines, and Ozalid type prints can be produced at the rate of 850 square feet per hour.

BLOUNT ALL-PURPOSE GRINDER

A grinder recently brought out by the J. G. Blount Co., Everett, Mass., for general service in either wood- or metal-working shops, is shown in the accompanying illustration. Three wheels are furnished for this machine to adapt it to many different service requirements. There is a coarse wheel, 10 by 1 1/2 inches, which is intended for general shop use, and on this wheel snagging or rough-grinding can be performed.



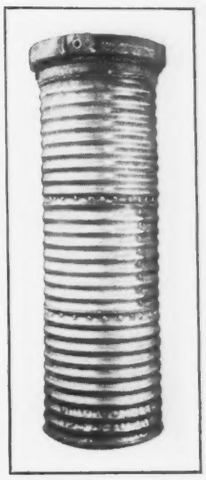
Blount Grinder for General Shop Use

A fine wheel of the same size is provided for grinding tools, chisels, plane-irons, etc. To facilitate such operations, the fine wheel is equipped with a special rest which is fully adjustable as to its angular relation with the wheel face. On the rest is fitted a screw-feed sliding clamp block for holding the tool and guiding it squarely across the wheel. This attachment insures the rapid grinding of tools to correct angles and curvatures. For grinding gages and inside-curved tools, a grinding cone is furnished.

The machine is of the motor-in-head type, the motor being fully enclosed and dustproof. The spindle runs in heavy-duty deep-grooved ball bearings. Double recessing of the flanges provides an effective seal against grit or dust entering either the bearings or the motor. The wheels are fitted with safety guards which are adjustable to compensate for wheel wear. The tool-rests are also adjustable.

"FUZON" STAINLESS STEEL ANNEALING POTS

Carburizing boxes, annealing pots and boxes, and other containers intended for use in connection with the heat-treatment of steel parts are now being manufactured from stainless steel by the Fusion Welding Corporation, Division of the Chicago Steel & Wire Co., 103rd St. and Torrence Ave., Chicago, Ill. The illustration shows a pot made for use in annealing wire. It weighs approximately 660 pounds, and is designed to replace a cast-steel pot weighing about 3300 pounds. In annealing 2000 pounds of wire in the new pot, it is necessary to heat only 2660 pounds of metal, as against 5300 pounds in the case of the cast-steel pot.

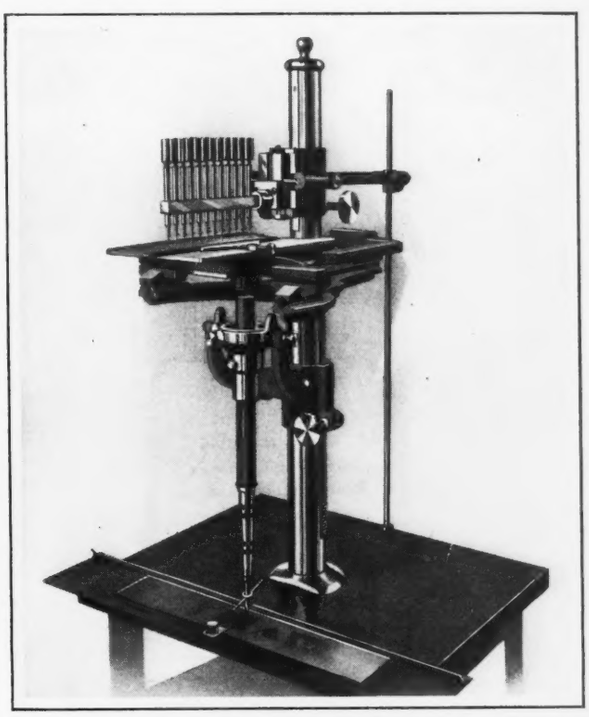


Annealing Pot Made of Stainless Steel

At the annealing point of wire, which is between 1350 and 1400 degrees F., the stainless steel shell hardly takes on color. Another advantage cited is that no sign of scale is produced over the exterior or interior surfaces of the pot. The pot shown is about 7 feet high and has an outside diameter of 24 inches. Its body is made of stainless steel containing 18 per cent chromium and 8 per cent nickel. The pot has a wrought-steel baseplate 7/8 inch thick which is welded to the body, and also a wrought-steel collar at the top about 1 inch thick, which is welded in place. Eight carbon-steel rods, 1/2 inch in diameter, are welded to the collar and to the base, while a steel plate is welded inside the pot so that the wire coils can easily be removed. The shell is made of No. 14 gage stainless steel.

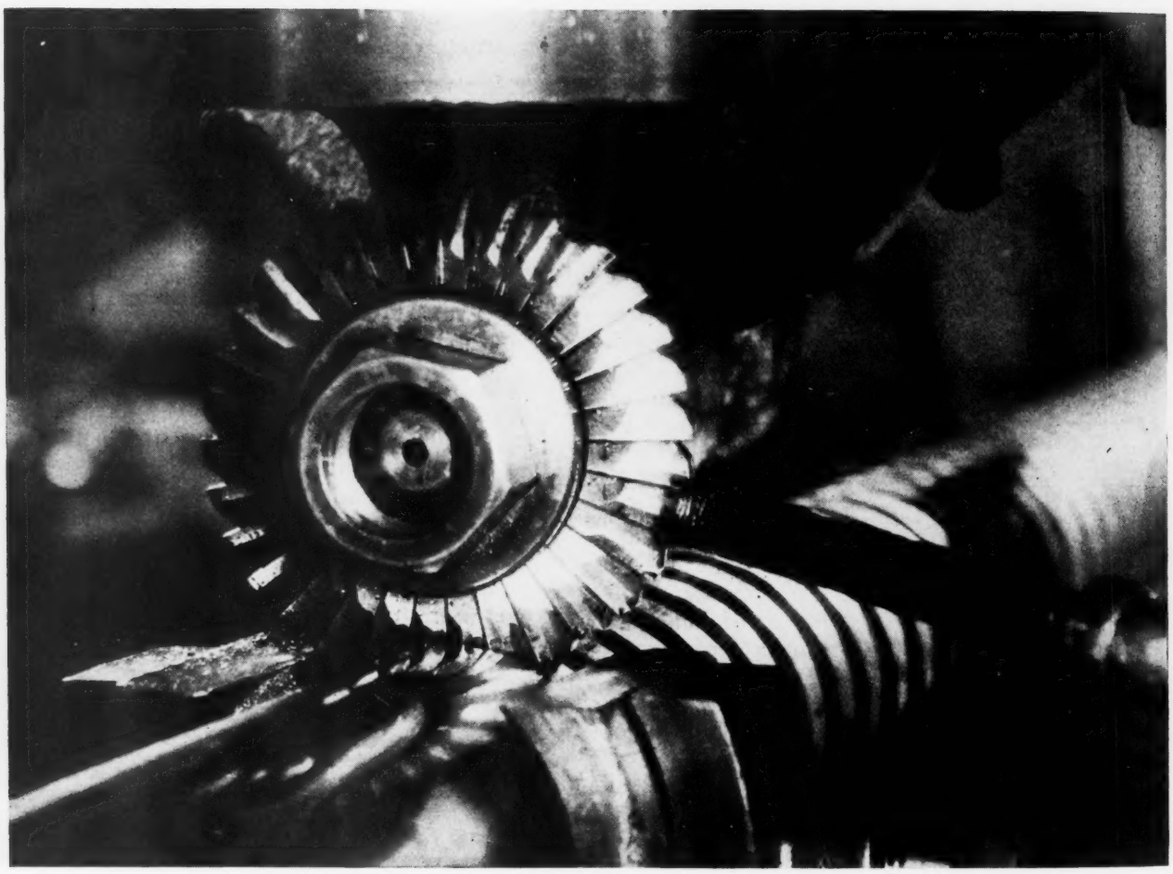
MULTIPLE-TOOL ENGRAVING MACHINE

Cutters, gages, rules, and other parts on which trademarks, numbers, or letters are to be etched with acid, can be marked in multiple with a model J engraving machine manufactured by the



Engraving Machine Arranged for Simultaneously Marking Twelve Parts

25 FEET *of the length of this b*



The cutters used on this job are 5¾" in diameter with a 1¼" pitch. The material is ground screw stock 3¾" in diameter, and the threads are produced for slightly over 25 feet of the length of the bar.

Brown & Sharpe Products

Milling Machines
Grinding Machines
Gear Cutting Machines
Screw Machines
Cutters and Hobs
Machinist's Tools
Gears Cut to Order

BROWN & SHARPE CUTTERS
GIVE LOWEST COST
WHEN YOU FIGURE
REAL COST

bar threaded with ONE CUT

for the actual cut of over 200 feet the cutters had to be good

HERE'S a cutter proving job—milling with one cut 25 feet of accurate thread. The design of these cutters permits a smooth cutting action without clogging because of ample chip clearance, and a long cutter life because of allowance for many sharpenings. The cutters give the required accuracy essential on a job of this kind and show no appreciable wear after milling a thread for the whole length of over 25 feet. The threads produced are very smooth and require a minimum of polishing.

The real value of good cutters is realized on a job like this where only cutters which give unfailing accuracy and continued reliability can be used. Whether your cutter jobs are just average or the toughest, you'll find that good cutters can do the job faster and better, giving the best results at the lowest real cutter cost.

It pays to buy good cutters. Keep a copy of Catalog No. 30 on hand for cutter reference.

The Cost of

Time Lost Removing Cutters
Plus Time Lost Replacing Cutters
Plus Lost Production
Plus Sharpening Cutters
Plus Original Purchase
Equals
Real Cost of Cutters

What is the Real Cost of Your Cutters?

BROWN & SHARPE

BROWN & SHARPE MFG. CO. PROVIDENCE, R. I., U. S. A.

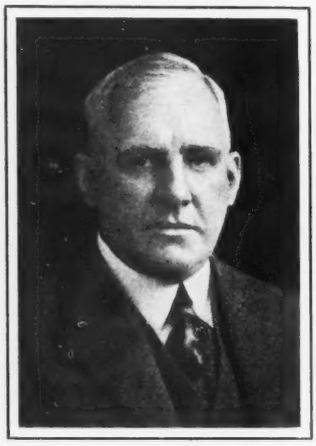
Engravers & Printers Machinery Co., Sag Harbor, Long Island, N. Y. In the accompanying illustration, this machine is shown equipped with twelve engraving tools for simultaneously marking a like number of parts positioned on an upper table. This table is readily manipulated beneath the engraving tools in any direction in a horizontal plane as desired, when the operator moves the stylus along master plates located on the stationary lower table. In this manner, the engraving tools are made to cut the wax or other resistance ground with which the work pieces are coated.

The stylus spindle is carried in a cradle which may be adjusted to various heights on the vertical column to increase or reduce the ratio between the movements of the stylus and the work-table. With one size of master plate, reductions can be instantly made from a size too small for practical use to an infinite number of larger sizes. Diamond points are employed for engraving on steel and steel points for marking on glass. The movements of the work-table are smoothly and easily accomplished by the provision of steel balls in the vee ways of the different table members. Vertical adjustments of the arm that carries the engraving tools are readily made to suit the height of work.

OBITUARIES

JAMES A. SMITH

James A. Smith, superintendent of the Schenectady Works of the General Electric Co., died at his home in Schenectady, N. Y., October 25, following a stroke suffered the night before.



James A. Smith

Mr. Smith was born in Hartford, Conn., in 1873. As a boy he worked on a farm. In 1888 he entered the employ of the Pratt & Whitney Co., Hartford, Conn., and a year later became a regular apprentice with the company, attending night-school meanwhile. During the latter part of his apprentice training he built the first pneumatic hammer ever made in America.

In 1893, after having just completed his apprenticeship, he was sent to Chicago to install the Pratt & Whitney Co.'s exhibit at the World Fair. In 1900, he was sent to install and demonstrate the company's exhibit at the Paris Exposition. In the meantime, he had taken a correspondence school course in mechanical engineering and became a designer of machine tools.

From 1901 to 1903 Mr. Smith was associated with the Niles-Bement-Pond Co., and in 1905 he was made superintendent of the Dutchess Tool Works, Fishkill Landing, N. Y., which position he held until he entered the employ of the General Electric Co., in 1910, as assistant to the mechanical superintendent. In a few months' time he was made superintendent of the motor department, and in 1913 he was promoted to general superintendent of the Schenectady Works, which position he occupied at the time of his death.

B. L. Delack, manager of the Schenectady Works of the General Electric Co., says of Mr. Smith, "He was endowed with mechanical genius of the highest order, and his knowledge of machine tool design and application was unsurpassed. His skill and experience made him a most useful and valuable counselor for any who sought his advice. He possessed unusual executive ability, and his acquaintanceship with the employes was of such a kindly character that he was genuinely loved and admired by them. His premature death is a great loss to the General Electric Co." Mr. Smith is survived by his wife, a daughter, and a son.

MILTON H. FESLER, sales manager of the Automatic Machine Co., Bridgeport, Conn., died at St. Lukes Hospital in Cleveland, Ohio, on November 8, following an operation for appendicitis. Mr. Fesler was on a Western business trip when he was taken with an attack of appendicitis, and was operated on, on October 27. At first the operation appeared to be successful, but he later suffered a relapse which proved fatal. Mr. Fesler was born in California twenty-nine years ago. He is survived by his father and mother, a wife, and two children.

GEORGE P. MERRILL, secretary-treasurer of Mitts & Merrill, 843 Water St., Saginaw, Mich., died October 14. Mr. Merrill was born in Saginaw, Mich., on September 29, 1887, and spent his entire life there. He was the grandson of George W. Merrill, who founded the business in the year 1854. He had been affiliated with the company since the completion of his education, and became secretary-treasurer in 1918. In addition to his official duties, he managed the machine tool part of the business.

* * *

PERSONALS

J. E. MATTHEWS, formerly eastern representative of the Moraine Products Co., Dayton, Ohio, has resigned.

HAROLD C. OSMAN, secretary of the Nugent Steel Castings Co., Chicago, Ill., and heretofore in charge of sales for that company, has been appointed works manager.

EUGENE BOUTON, formerly supervisor of time study of the Chandler-Cleveland Motors Corporation, is now connected with the J. I. Case Threshing Machine Co., Racine, Wis.

P. C. HOUGH, of the Service Department of the Black & Decker Mfg. Co., Towson, Md., is leaving for Australia to establish service facilities for the users of Black & Decker products in Australia and New Zealand.

JOHN A. MANLEY, who has for the last three years been manager of sales development for Fairbanks, Morse & Co., Chicago, Ill., has been elected vice-president in charge of sales. Mr. Manley was formerly manager of accounts for the advertising agency of Henri, Hurst & McDonald of Chicago. In connection with his advertising work, he made a detailed study of the problems of industrial business development, and it was the result of this work that brought him into the Fairbanks Morse organization. Upon graduating from Northwestern University in 1911, Mr. Manley entered the sales department of the Republic Tire & Rubber Co. After four years with this organization he joined the advertising staff of one of the Chicago newspapers, later making the connection with the advertising agency previously mentioned.

John A. Manley

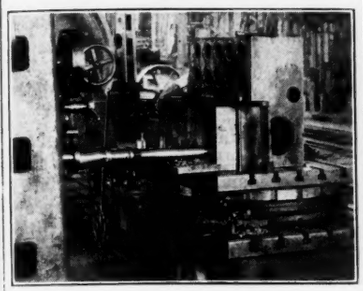
FRANK J. WACHTER, formerly connected with the Landers, Frary & Clark Co. in the sales department, has been made sales manager of the Union Mfg. Co., New Britain, Conn., manufacturer of chucks, hoists, and gray iron castings.

HOWARD E. OBERG, who for several years has represented the Billings & Spencer Co.'s machinery division at Detroit, Mich., has been transferred to the main office at Hartford, and been made sales manager of the machinery division.

J. V. FRANKLIN, salesman with the British office of Black & Decker Mfg. Co., Towson, Md., is on his way to the United States and will spend some time at the Towson factory and in various automotive and industrial centers of the country.

BARNEY G. TANG, assistant general superintendent of the Schenectady Works of the General Electric Co., has been made general superintendent to succeed the late James A. Smith. Mr. Tang has been connected with the company since 1898.

TYPICAL PERFORMANCE

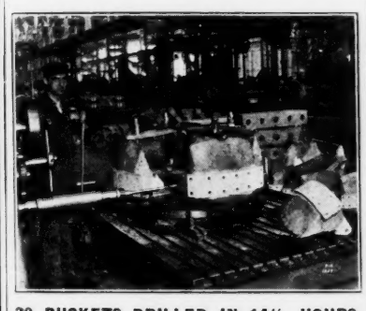


Total time including setting 150 hours, 42 min.

Pump Body for 24,000 Bbl. Oil Pipe Line Pump Machine clamped on 4 ft. Turn Table.
Material: Open Hearth Steel 1.30% Carbon.
Size: 23" x 29½" x 36½".
Weight: 5700 lbs.

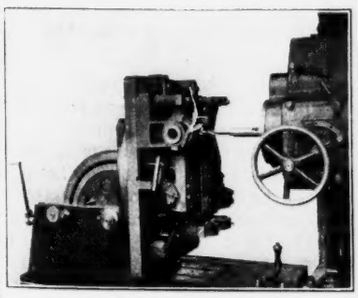
Drill & Tap						
"	"	10	Holes	1¼" dia.	x	1½" deep
"	"	12	"	1⅛" "	x	1⅜" "
"	"	80	"	1" "	x	1¼" "
"	"	28	"	⅞" "	x	1⅛" "
"	"	18	"	¾" "	x	1" "
"	Bore	1	"	3½" "	x	36½" "
"	"	5	"	3⅛" "	x	26" "
"	"	5	"	3½" "	x	10" "
"	"	20	"	4" "	x	7½" "
"	"	10	"	2⅜" "	x	2" "
"	"	10	"	2¼" "	x	4" "
						(See note A)
"	"	20	"	3⅛" "	x	2½" "
"	"	1	"	8½" "	x	33¼" "

Note "A"—These holes were drilled at different angles to the horizontal and vertical planes which required six different angular settings of the table.



20 BUCKETS DRILLED IN 14¼ HOURS.
Floor to Floor Time
Every Pair of Holes at a Different Angle

Four ditcher buckets, each weighing 85 pounds, mounted on a 4' turntable. Twelve 13/16" holes drilled thru 1½" material. Two 1" holes drilled thru ¾" material. Drilled from 8 positions with one clamping.



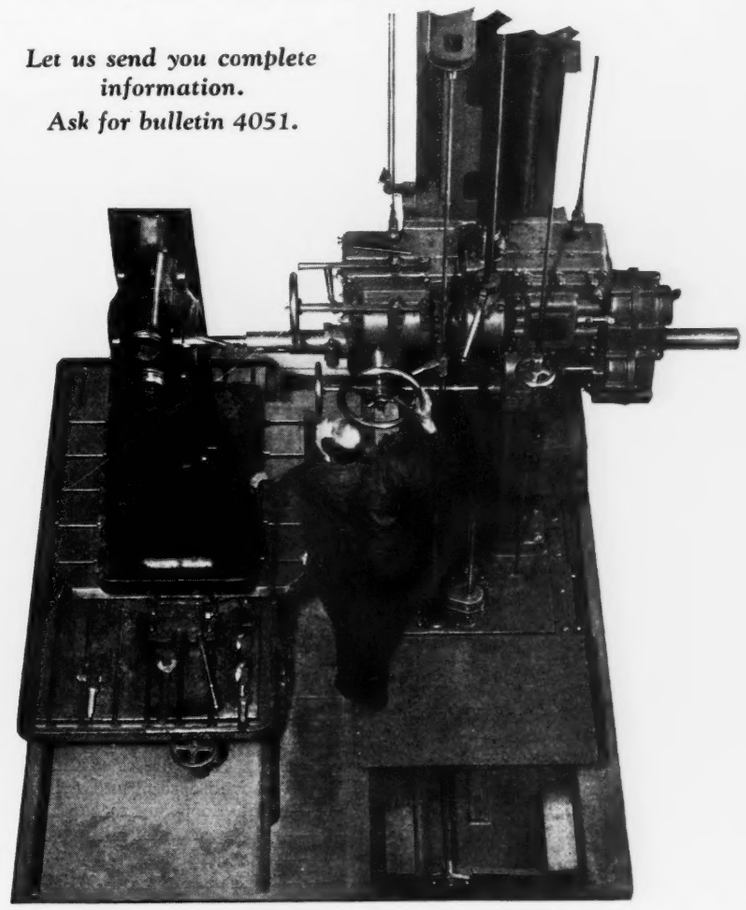
A Ryerson Horizontal, drilling bearings for the car body of an excavator crane. Work mounted on a horizontal tilting and revolving table, tilted full 90 degrees.

Every Move Counts

The operator of a Ryerson Horizontal can plant his feet in one spot and bring the work to him. He does not have to climb around and over odd-shaped castings all day. His energy goes into additional work and he is able to keep up production as the day grows.

Anything in the shop—small pieces on a production schedule, or the largest casting can be economically handled by a horizontal. The unusual vertical travel of the spindle and the rolling work table gives this machine a capacity unequaled by any other type of drilling machine and thus eliminates frequent resetting of work.

Let us send you complete information.
Ask for bulletin 4051.



JOSEPH T RYERSON & SON INC.
Established 1842

Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Pittsburgh, Philadelphia, Boston, Jersey City, New York, Richmond, Houston, Tulsa, Los Angeles, San Francisco, Denver, Minneapolis, Duluth.

Drill it Horizontally

Ed E. Mooers has been made general manager of the Hilliard Corporation, Elmira, N. Y., maker of the Hilliard clutch and "Refinoil" oil reclaiming machines. Mr. Mooers was formerly associated with the Thatcher Mfg. Co., of Elmira, as production superintendent.

R. M. Porter has been added to the sales force of the Van Dorn Electric Tool Co., Cleveland, Ohio, and will cover the Philadelphia and Camden territories. Mr. Porter will make his headquarters in Philadelphia. R. F. Hutt has been placed in charge of the field covered by the Minneapolis office, and will be located in Minneapolis.

Atherton Clark of the export department of the Black & Decker Mfg. Co., Towson, Md., started early in November on a year's trip to Hawaii, Japan, China, Philippine Islands, Malaya, Dutch East Indies, India, Australia, and New Zealand for the purpose of visiting the distributors of Black & Decker products in those countries, and establishing new distributing connections.

George H. Adams is the new director of sales of the Bunting Brass & Bronze Co., Toledo, Ohio. Mr. Adams has had a varied experience with the sales and engineering problems of the bearing industries. Prior to his connection with the Bunting Brass & Bronze Co. he was automotive engineer of the S K F Industries. He was also chief engineer of the Bock Bearing Co. of Toledo.

E. J. Frost, formerly president of the Frost Gear & Forge Co., Jackson, Mich., has sold his interests in this company and is no longer engaged in the gear business. He has, therefore, tendered his resignation to the American Gear Manufacturers Association, of which he was president during the year 1927-1928. The association, in accepting Mr. Frost's resignation as an active member, elected him to honorary membership.

Frederick S. Blackall, Jr., has been appointed general manager of the Taft-Peirce Mfg. Co., Woonsocket, R. I., succeeding his father, the late Frederick S. Blackall. In addition to filling the position of general manager, Mr. Blackall is assistant secretary of the company and a member of the board of directors. For the last six years he has been active in managing the affairs of the company, and is well qualified to assume the responsibilities of his new position. He is a member of the American Gage Design Committee, whose report he is engaged in editing, and of the American Society for Steel Treating.

* * *

TRADE NOTES

Joseph T. Ryerson & Son, Inc., 16th and Rockwell Sts., Chicago, Ill., have taken over the sale of the Millers Falls line of portable electric tools.

Boye & Emmes Machine Tool Co., Cincinnati, Ohio, has appointed Knickerbocker, Cram & Co., Inc., 7 E. 42nd St., New York City, agent for the Boye & Emmes line of lathes in the New York territory.

Union Mfg. Co., New Britain, Conn., has appointed E. M. Hanson & Co., 130 N. 4th St., Philadelphia, Pa., sole distributor for the Union line of chucks, chain hoists, and trolleys in the Philadelphia territory.

Diamond Chain & Mfg. Co., 409 Kentucky Ave., Indianapolis, Ind., has made arrangements with the I. H. Dexter Co. of Goshen, N. Y., for the manufacture and marketing of the Clark flexible coupling. This coupling has been made and sold for the last fifteen years by the I. H. Dexter Co.

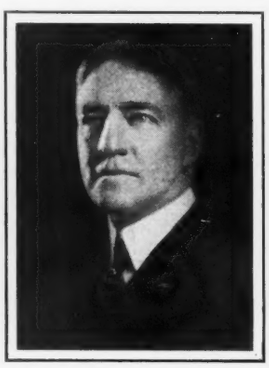
Latrobe Tool Co. and J. M. Carpenter Tap & Die Co., which are under the same management, announce that a new factory branch store has been opened at 512 Arch St., Philadelphia, Pa. The W. A. Laub Co., 1700 Walnut St., Philadelphia, will continue to sell the line of tools made by these concerns, as one of their dealers.

Timken Roller Bearing Co., Canton, Ohio, has found it necessary to make a radical expansion in its production facilities, due to the increasing demand for its products. The complete program that has been put into effect will provide the necessary equipment for raising the company's present output of 175,000 bearings per day to over 200,000.

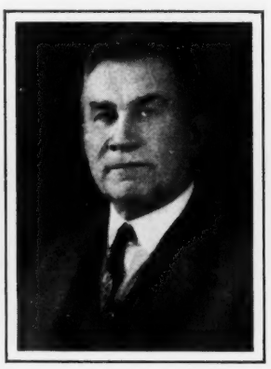
C. P. Pease Co., 822 N. Franklin St., Chicago, Ill., has moved its New York sales office and display room from the Grand Central Terminal Bldg. to new quarters in the Ashforth Bldg., 12 E. 44th St., where the entire seventh floor is occupied by this company. The larger quarters give improved facilities for stock and the display of a complete line of blueprinting machinery and drafting-room furniture. The office is under the direction of T. K. Murney, eastern sales manager.

Prest-O-Lite Co., Inc., 30 E. 42nd St., New York City, has opened a new acetylene plant at East Ave. and Short St., South Charleston, W. Va. J. J. Robinson is in charge of the plant, and S. P. Murphey, whose headquarters are at Cincinnati, is district superintendent. Operations have also begun in a new gas plant at 3155 27th Ave., N., Birmingham, Ala. This plant will supply the local demand for dissolved acetylene used in oxy-acetylene welding and cutting. A. J. Topham is plant superintendent, and G. A. Andrews is district superintendent.

George H. Adams



C. B. Auel



L. A. Schumacher

G. W. Goebel

Billings & Spencer Co., Hartford, Conn., announce a reorganization of the company, which comprises both a financial reorganization and changes in the equipment and layout of the plant. Considerable new machinery is to be purchased and the present mechanical equipment is to be moved to the first floor, leaving the two upper floors available for rental. David J. Post has been elected chairman of the Board, and A. H. Deute, vice-president and general manager. Frederick C. Billings remains president and treasurer. The old Billings & Spencer line of drop-forging machinery will be continued, and the B & S line of branded merchandise will be expanded, the latest addition to which is a complete line of forged-steel golf clubs.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., announces the creation of a new department, which is made up of the consolidation of the Works Standards division and the Employes' Service Department, the new department being known as the Employes' Service and Works Standard Department. C. B. Auel, formerly manager of the Employes Service Department, has been placed in charge of the new department. L. A. Schumacher, formerly superintendent of the Inspection and Test Department, has been appointed manager of the Standards Division of the new department. It has also been announced that the two inspection departments formerly operated in East Pittsburgh have been combined into one known as the Inspection and Test Department, with G. W. Goebel as superintendent.

The Most Efficient Man is the Man with an Idea

and the most efficient machine is the machine made around an idea and not merely to sell. Such a machine is the

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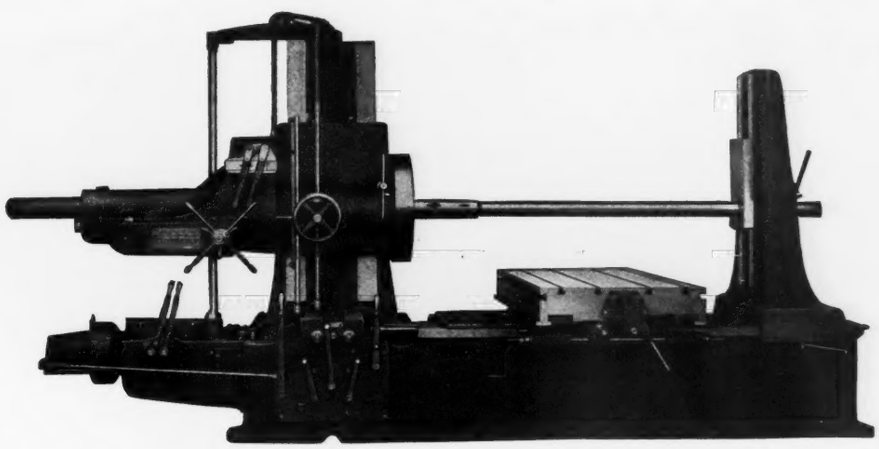
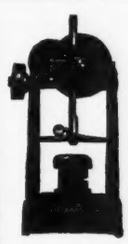


ITS RECORD IS OUR BEST AD



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FOREIGN AGENTS: Allied Machinery Co., Barcelona, Zurich. V. Lowener, Copenhagen, Oslo, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam. Andrews & George Co., Tokyo. Ing. M. Kocian & G. Nedela, Prague. Emanuele Mascherpa, Milan, Italy.

COMING EVENTS

DECEMBER 3-7—Annual meeting of the American Society of Mechanical Engineers to be held in the Engineering Societies Building, New York City. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

DECEMBER 3-8—National Exposition of Power and Mechanical Engineering in the Grand Central Palace, New York City.

DECEMBER 6—Annual meeting of the Power Transmission Association at Hotel Commodore, New York City. W. S. Hays, 644 Drexel Bldg., Philadelphia, Pa., executive secretary.

JANUARY 14-18, 1929—Western Metal Congress and Western States Metal and Machine Tool Exposition at Los Angeles, Cal., under the auspices of the American Society for Steel Treating; headquarters, Shrine Auditorium. Secretary, W. H. Eisenman, 7016 Euclid Ave., Cleveland, Ohio.

JANUARY 15-18—Annual meeting of the Society of Automotive Engineers at the Book-Cadillac Hotel, Detroit, Mich. Coker F. Clarkson, secretary, 29 W. 39th St., New York City.

APRIL 8-12—American Foundrymen's Association convention at Hotel Stevens, Chicago, Ill. Headquarters of association, 140 S. Dearborn St., Chicago, Ill.

SEPTEMBER 9-13—Annual convention of the American Society for Steel Treating at Cleveland, Ohio. W. H. Eisenman, secretary, 7016 Euclid Ave., Cleveland, Ohio.

SEPTEMBER 9-13—Eleventh National Metal Exposition under the auspices of the American Society for Steel Treating at the Cleveland Public Auditorium, Cleveland, Ohio. For further information address W. H. Eisenman, secretary, 7016 Euclid Ave., Cleveland, Ohio.

SEPTEMBER 30-OCTOBER 4, 1929—Exposition of the National Machine Tool Builders Association to be held in the Cleveland Public Auditorium Buildings, Cleveland, Ohio. Roberts Everett, 225 W. 34th St., New York City, exposition manager.

CALENDARS RECEIVED

UNION SWITCH & SIGNAL CO., Swissvale, Pa., manufacturer of drop-forgings, is distributing its regular annual calendar for the year 1929.

SOCIETIES, SCHOOLS AND COLLEGES

UNIVERSITY OF DETROIT, Detroit, Mich. Bulletin of the College of Engineering, 1928-1929.

WORCESTER POLYTECHNIC INSTITUTE, Worcester, Mass. Annual catalogue for 1928-1929, containing calendar and outline of courses.

NEW BOOKS AND PAMPHLETS

DIE-HEAD CHASERS. 12 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Simplified Practice Recommendation R51-28.

STANDARDS OF THE HYDRAULIC SOCIETY (fifth edition). 80 pages, 8½ by 11 inches. Published by the Hydraulic Society, 90 West St., New York City. Price, 50 cents.

TRADE STANDARDS ADOPTED BY THE COMPRESSED AIR SOCIETY (third edition). 47 pages, 8½ by 11 inches. Published by the Compressed Air Society, 90 West St., New York City. Price, 50 cents.

OUTDOOR RECREATION FOR EMPLOYES. 20 pages, 8 1/4 by 10 1/2 inches. Distributed by the Policyholders' Service Bureau of the Metropolitan Life Insurance Co., 1 Madison Ave., New York City, as Report No. 76.

THE INTERNATIONAL TEMPERATURE SCALE. By George K. Burgess. 6 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Research Paper No. 22 of the Bureau of Standards. Price, 5 cents.

STRAIN MARKINGS IN MILD STEEL UNDER TENSION. By Henry S. Rawdon. 19 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Research Paper No. 15 of the Bureau of Standards. Price, 15 cents.

MACHINERY IN THE LIBRARY. By Arthur E. Bostwick. 24 pages, 6 by 9 inches. Distributed by the St. Louis Public Library, St. Louis, Mo.

The pamphlet contains a description of the mechanical devices used in the St. Louis Public Library.

STEEL FOR CASEHARDENING—NORMAL AND ABNORMAL STEEL. By S. Epstein and H. S. Rawdon. 44 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Research Paper No. 14 of the Bureau of Standards. Price, 35 cents.

THE USE OF RESEARCH IN SALES MANAGEMENT. 23 pages, 8 1/4 by 10 1/2 inches. Prepared for the Research Committee of the New England Council by the Policyholders' Service Bureau of the Metropolitan Life Insurance Co., 1 Madison Ave., New York City.

TESTS OF THE FATIGUE STRENGTH OF STEAM TURBINE BLADE SHAPES. By Herbert F. Moore, Stuart W. Lyon, and Norville J. Alleman. 38 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 183 of the Engineering Experiment Station. Price, 25 cents.

WEAR AND MECHANICAL PROPERTIES OF RAILROAD BEARING BRONZES AT DIFFERENT TEMPERATURES. By H. J. French, S. J. Rosenberg, W. L. C. Harbaugh and H. C. Cross. 79 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Research Paper No. 13 of the Bureau of Standards. Price, 35 cents.

1928 SUPPLEMENT TO BOOK OF A.S.T.M. STANDARDS. 195 pages, 6 by 9 inches. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa. Price, $1.50.

This pamphlet contains ten revised and thirty-one newly adopted standards relating to metals and non-metallic materials, supplementing Parts I and II of the 1927 Book of Standards, published by the society.

PATENTS THROUGHOUT THE WORLD. By William Wallace White and Byfleet G. Ravenscroft. 398 pages, 6 by 9 inches. Published by Trade Activities, Inc., 36 W. 44th St., New York City. Price, $10.

This is the second edition of a book containing a digest of patent laws. It is now issued in loose-leaf form in order that new laws and changes in laws can be added when necessary. The book covers all the countries of the world, arranged in alphabetical order.

A.S.S.T. HANDBOOK. 669 pages, 4½ by 7¼ inches. Published by the American Society for Steel Treating, 7016 Euclid Ave., Cleveland, Ohio. Price, $7.50. (Free to members of the society.)

This handbook has been published in loose-leaf form for almost five years, and is now issued in bound form for the first time. It contains comprehensive and concise information on metallurgical practices pertaining to the manufacture, treatment, and use of metals. One of the features of the book is a classified buyers' guide.

BOOK OF BUSINESS STANDARDS. By J. George Frederick. 255 pages, 5 by 7 1/2 inches. Published by the Commercial Standards Council, 19 Park Place, New York City. Price, $2.

This is the second edition of a book compiled and written for practical guidance in the interest of better business. Part I describes conditions and clarifies the definitions of business procedure. Part II gives concrete standards and codes already in practice among various groups. It is believed that more universal adoption of such codes will be an important aid in securing more permanent prosperity and lower costs.

HOW TO BEGIN THE APPLICATION OF ARC WELDING IN PRODUCTION MANUFACTURING. 32 pages, 6 by 9 inches. Published by the Lincoln Electric Co., Cleveland, Ohio, as a supplement to its book entitled "Arc Welding—The New Age in Iron and Steel." Price, 50 cents. Distributed free to owners of previous book.

This pamphlet deals principally with the redesign of machinery in order to take advantage of arc-welded construction. Many line drawings are used to show how standard steel shapes can be utilized to build up structures that were formerly cast.

STANDARD AND TENTATIVELY ADOPTED METHODS OF TESTING AND GRADING FOUNDRY SANDS. 94 pages, 6 by 9 inches; 31 illustrations. Published by the American Foundrymen's Association, 222 W. Adams St., Chicago, Ill. Price, $3.

This publication is a revision of the Foundry Sand Test Methods issued by the joint committee on molding sand research in 1924 and contains, in addition, descriptions of testing procedures developed since 1924. Controlling specifications are given, with general information as to methods of conducting tests and details of construction of apparatus that has been found satisfactory for performing the tests.

FUNCTIONS OF THE PRODUCTION EXECUTIVE. 26 pages, 5 1/2 by 7 3/4 inches. Published by the Policyholder Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York City.

This is the twelfth of a series of business organization leaflets. The present booklet presents in detail a careful first-hand study of the position of production executives in a number of typical business organizations, including such companies as the Yale & Towne Mfg. Co., the Atlas Ball Co., the Nash Motors Co., etc. One of the features of the report is a graphic chart showing the distribution of the functions of the chief production executive in fourteen industrial plants.

INSTRUCTION SHEETS FOR BURGHARDT'S MACHINE TOOL OPERATION (Parts I and II). By Henry D. Burghardt. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price, two parts bound together, $1; in separate envelopes, 50 cents each.

This publication consists of a series of loose-leaf instruction sheets intended to supplement Burghardt's book on "Machine Tool Operation." It is believed that printed sheets of this kind are less likely to be misunderstood than verbal instructions. Part I deals with the use of small tools, including scales, calipers, micrometers, hacksaws, files, taps, threading dies, and operations on the lathe. Part II contains instructions for performing operations on the drill press, shaper, planer, milling machine and grinding machine.

ENGINEERING DRAWING. By Harvey H. Jordan and Randolph P. Hoelscher. 404 pages, 6 by 9 inches. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Price, $3, net.

This is the second edition of a book on engineering drawing prepared for the benefit of those desiring to perfect themselves in the technique of drawing. The book is divided into two parts and an appendix. Part I deals with the four fundamental kinds of projections, and their applications in mechanical and free-hand drawing. Part II treats of the applications of the principles laid down in Part I to the various

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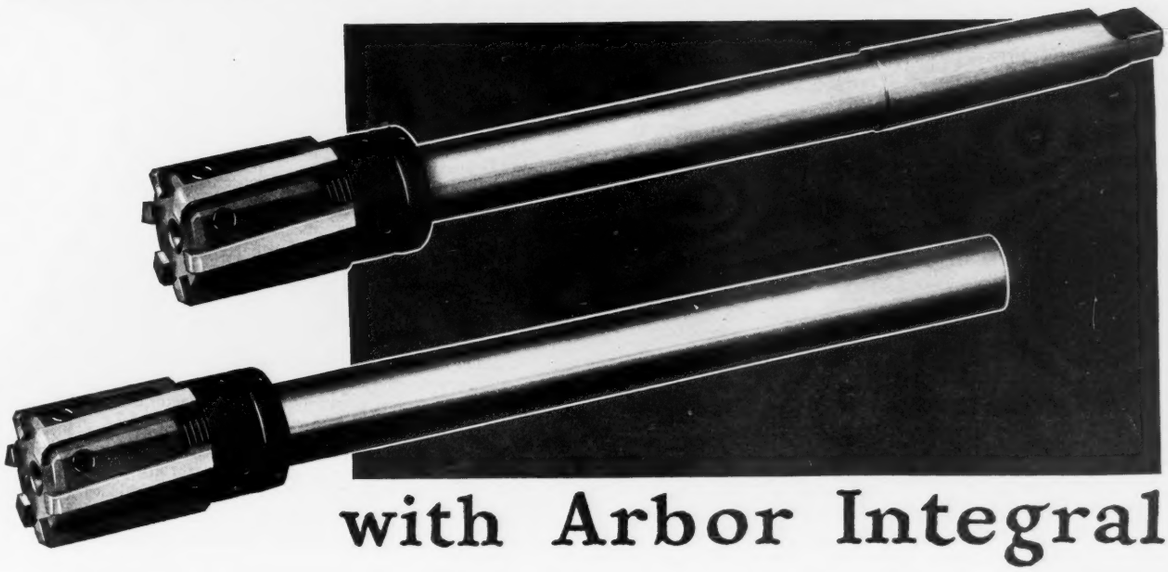

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fields of drafting, such as architectural, structural, map, patent office, etc. The appendix contains symbols and conventions in various fields of drawing, geometrical constructions, and tables of data generally needed by students in the drawing-room or office. Considerable new material has been added in this edition, and much of the text has been revised to simplify the presentation.

THE THEORY OF FILM LUBRICATION. By R. O. Boswall. 279 pages, 5½ by 8¼ inches. Published by Longmans, Green & Co., 55 Fifth Ave., New York City. Price, $5.

As stated in the preface of this book, recent developments in the design and construction of large bearings indicate a gradually increasing tendency to utilize what is now generally known as film lubrication, an essential feature of which is that the bearing surfaces should be completely separated by a continuous layer or film of lubricant. Little information has been published on this particular branch of lubrication, and this book has been written with the object of filling the gap in the literature on this subject. The book contains a detailed description of the mathematical principles governing the operation of film lubrication, coupled with an explanation of the way in which these principles can be applied to the various problems that arise in connection with the film lubrication of thrust and journal bearings.

THE CONSTRUCTION OF ALIGNMENT CHARTS. By George W. Swett. 92 pages, 5½ by 8 inches. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Price, $2.

Comparatively little material is available on the principles underlying the construction of alignment charts, and most of the matter that has been published is difficult to comprehend by a student with but limited mathematical knowledge. On this account, this work has been prepared for those who wish to gain a workable knowledge of the subject, but who are not interested in a highly specialized mathematical treatise. The presentation of the mathematics has been kept as simple as possible, and should be easily understood by anyone familiar with algebra, plane geometry, and the elements of trigonometry. The attempt has been made to present in as simple a manner as possible a direct method of procedure in the construction of alignment charts for equations of various forms. The equations used in the illustrative examples have been taken from engineering practice.

THOMAS' REGISTER OF AMERICAN MANUFACTURERS (1928-1929). 4500 pages, 9 by 12 inches. Published by the Thomas Publishing Co., 461 Eighth Ave., New York City. Price, $15.

The new edition of this well-known buyers' guide has been thoroughly revised and contains 250,000 changes. The arrangement is the same as in previous editions. There are three principal sections, the classified section which covers all the manufactured products in the United States, printed on white pages; the alphabetical list of manufacturers, with home and branch offices, printed on blue pages; and the list of trade names with manufacturers' names and addresses, printed on pink pages. The index is printed on yellow paper, the different colors making it easy to refer to the section desired. As in other editions, capital ratings are given for each firm. These ratings are not intended to indicate credit but merely to give an idea of the approximate minimum capital. The appendix contains a list of banks, boards of trade and other commercial organizations, trade associations, and leading trade papers. This directory will prove of great value to buyers in all lines of manufacture, but also to sales departments in compiling lists of names.

INDUSTRIAL EXPLORERS. By Maurice Holland, 347 pages, 6 by 9 inches. Published by Harper & Bros., 49 E. 33rd St., New York City. Price, $3.

This book contains an interesting word picture of the work, personalities, and peculiarities of the nation's leaders in industrial research. The book is written in a readable style and is a fascinating story of the romance behind modern industrial progress. Among those whose work is outlined are: Willis R. Whitney, director of Research Laboratories, General Electric Co.; Frank B. Jewett, vice-president, American Telephone and Telegraph Co. and president of the Bell Telephone Laboratories; Elmer A. Sperry, chairman, Board of Directors, Sperry Gyroscope Co.; Samuel C. Prescott, director, Department of Biology and Public Health, Massachusetts Institute of Technology; L. H. Baekeland, Bakelite Corporation; A. D. Little, president, Arthur D. Little, Inc.; C. E. Skinner, assistant director of engineering, Westinghouse Electric & Mfg. Co.; Harry E. Barnard, president, American Institute of Baking; Charles L. Reese, chemical director, E. I. du Pont de Nemours & Co.; William H. Miller, director of research, Curtiss Aeroplane & Motor Co.; and men of equal importance in other industries.

LABOR MANAGEMENT. By Gordon S. Watkins. 726 pages, 5½ by 8¼ inches. Published by the A. W. Shaw Co., Chicago, Ill. Price, $5, net.

The major purposes of this book, according to the author's preface, are to analyze the problems of human relations in industry and to present those principles and methods of procedure that intelligent understanding and practical experience have proved essential to the successful management of employes. Although written primarily as a text for college and university classes in personnel management, the book should also be helpful to employers and general readers who desire to familiarize themselves with recent developments in this field. The text is divided into eight parts as follows: Introduction; The Historical Background; Psychological Aspects of the Problem; The Structure and Functions of Personnel Organization; Problems and Methods of Recruitment, Selection, and Placement; Problems and Methods of Maintenance; Industrial Government; and Conclusion. Among the important problems treated are labor turnover, education and training of employes, wage systems and financial incentives, employe stock ownership, health maintenance, prevention of accidents, working environment, housing, etc.

LAWS OF MANAGEMENT APPLIED TO MANUFACTURING. By L. P. Alford. 266 pages, 6 by 8¾ inches. Published by the Ronald Press Co., 15 E. 26th St., New York City. Price, $4.

For many years the writer of this book has been interested in formulating fundamental principles of manufacturing organization and management. The results of two years' active search and study were presented by him in December, 1926, at the annual meeting of the American Society of Mechanical Engineers in a paper entitled, "Laws of Manufacturing Management." In this paper was given an organized group of fundamentals, as a code of operation for executives of manufacturing concerns. As a result of the discussion evoked by this paper and correspondence relating to it, these laws of management have now been brought together in book form. The book contains about fifty laws formulated in the original paper, but the discussion has been greatly amplified. For each law appropriate examples are given, showing its application in specific manufacturing concerns, together with improvements and savings that have come from its adoption. The text is divided into thirteen chapters dealing with the following subjects: Progress in Manufacturing; Progress in Management; Laws of Manufacturing Management; Law of Leadership; Laws of Executive Work; Laws of Specialization and Standardization; Laws of Production Management; Laws of Material Management; Laws of Individual Productivity; Laws of Wage Payment; Laws of Safety and Maintenance; Laws of Economy; and The Spirit of the Laws.

NEW CATALOGUES AND CIRCULARS

ELECTRIC FITTINGS. Crouse-Hinds Co., Syracuse, N. Y. Bulletin 2114, illustrating the new Obround condulet with wedge-nut fasteners.

DIE-CASTING ALLOY. New Jersey Zinc Co., 160 Front St., New York City. Research bulletin treating of the characteristics of "Zamak," a zinc-base die-casting alloy.

VENTILATING EQUIPMENT. American Blower Corporation, Detroit, Mich. Circular treating of the application of American Blower electric ventilating equipment in garages.

HOISTS. Union Mfg. Co., New Britain, Conn. Leaflet outlining the features and advantages of Union hoists. Capacities and list prices of the various sizes are included.

HEATING EQUIPMENT. American Blower Corporation, Detroit, Mich. Bulletin 7418, containing data on "Sirocco" unit heaters of high- and low-pressure types for industrial use.

RECORDING INSTRUMENTS. Bristol Co., Waterbury, Conn. Catalogue 1900, descriptive of Bristol long-distance electric transmitting and recording system for factories or field work.

CHUCKS. Union Mfg. Co., New Britain, Conn. Circular illustrating the features of construction of the New Britain drill chuck. Tables of dimensions and prices are included for the various sizes.

TURRET LATHES. Jones & Lamson Machine Co., Springfield, Vt. Pamphlet illustrating the successive steps in machining a certain job from bar stock. The production time for each operation is included.

STEEL FACTORY AND OFFICE EQUIPMENT. Angle Steel Stool Co., Plainwell, Mich. Catalogue C, descriptive of the construction and features of all types of steel factory and office equipment.

DIES AND STAMPINGS. Detroit Stamping Co., 3445 W. Fort St., Detroit, Mich. General folder No. 13, containing dimensions of combination dies for making flat and concentric washers; gang washer dies; and round dies.

CONVEYING SYSTEMS. Reading Chain & Block Corporation, Reading, Pa. Catalogue 56, descriptive of Reading monorail conveying systems. Specifications, including dimensions and prices, are given for the hoists and trolleys.

HIGH-SPEED CUTTING ALLOY. Carboloy Co., Inc., 350 Madison Ave., New York City. Pamphlet descriptive of the physical properties, characteristics, and field of application of "Carboloy," a remarkable new cutting alloy.

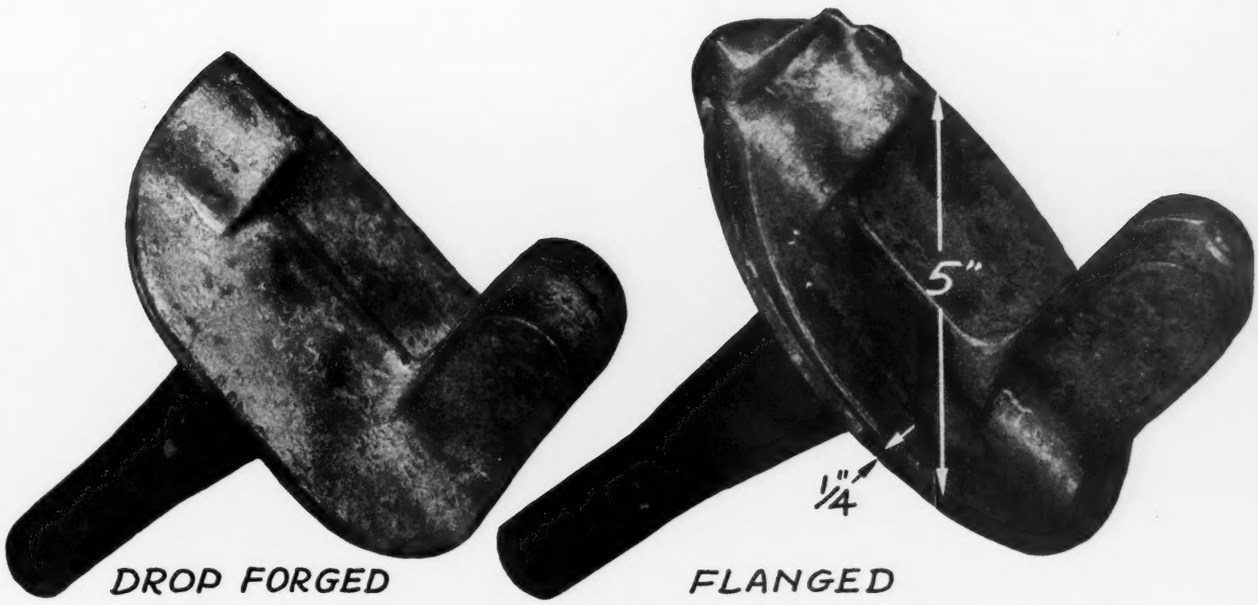
AIR-OPERATED DEVICES. Logansport Machine Co., 529 Market St., Logansport, Ind. Catalogue R-23, illustrating the Logansport line of air-operated devices, including air cylinders, valves, chucks, vises, arbor presses, etc.

ROLL FORMING MACHINES. Niagara Machine & Tool Works, 637-697 Northland Ave., Buffalo, N. Y. Card containing calendar for six months, from October, 1928, to March, 1929, and illustrating the Niagara slip roll former.

MILLING CUTTERS. Goddard & Goddard, Detroit, Mich. Pamphlet entitled, "Don'ts for Cutter Grinders," treating of the importance of correct grinding or sharpening of high-speed steel metal cutting tools, and the effect of incorrect sharpening.

GEARS. Boston Gear Works Sales Co., Norfolk Downs, Mass. General catalogue 48, listing Boston standardized gears, speed reducers, and chain drives. Dimensions and prices are included for the complete line, and a general index is provided.

FLEXIBLE SHAFT EQUIPMENT. Stow Mfg. Co., Inc., Binghamton, N. Y. Circular containing data on Stow portable electric drills. Bulletin containing engineering data and illustrations of the Stow line of flexible shafts and flexible shaft machines.



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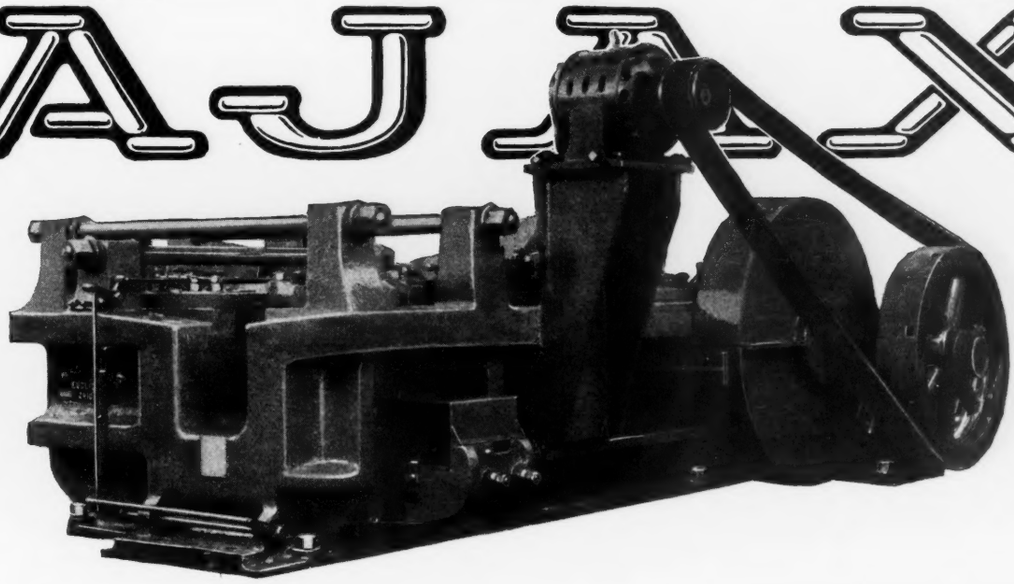

FILING AND SAWING MACHINES. Marburg Bros., Inc., 90 West St., New York City. Circular illustrating and describing Marburg combination filing and sawing machines. Examples of typical classes of work performed on these machines are also illustrated.

BALING PRESSES. Ohio Cultivator Co., Bellevue, Ohio. Bulletin descriptive of the various types of baling presses made by this company. The advantages and special features of this type of press are pointed out, and specifications are given for the three different sizes.

NICKEL STEEL. International Nickel Co., Inc., 67 Wall St., New York City. Third of a series of folders illustrating applications of nickel steel in various industries. This folder illustrates the use of these steels in the construction of industrial machinery and equipment.

WIRE-FORMING MACHINERY. Baird Machine Co., Bridgeport, Conn. Circular illustrating Baird four-slide wire and ribbon metal formers, spring making machines, foot and bench power presses, automatic power presses, tandem or two-slide presses, tumbling equipment, and chucking machines.

MATERIAL HANDLING EQUIPMENT. Cleveland Electric Tramrail Division of the Cleveland Crane & Engineering Co., Wickliffe, Ohio. Pamphlet entitled "Rolled Products Handled Overhead," illustrating the application of the Cleveland tramrail system in factories handling rolled products.

GEAR SHAPERS. Fellows Gear Shaper Co., Springfield, Vt. Catalogue illustrating and describing in detail the 6A type gear shaper, which is especially adapted for production work on gears up to 18 inches pitch diameter by 5 inches face. Complete instructions for operating this machine are included.

BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Circular containing reproductions of photographs showing the different results obtained in machining two similar pieces of work on an automatic lathe with plain spindle and on an automatic lathe equipped with a ball-bearing spindle.

COOLANTS. E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa. Booklet descriptive of "Hocut," a transparent water soluble metal cutting coolant. The booklet treats of the physical properties, advantages and uses, instructions for mixing, and application on various classes of work.

SPEED REDUCERS. D. O. James Mfg. Co., 1120 W. Monroe St., Chicago, Ill. Catalogue 166, describing, illustrating, and listing completely every type of speed reducer made by this company, including planetary spur reducers, heavy-duty worm reducers, medium-duty worm reducers, and herringbone reducers.

SILENT GEARS. General Electric Co., Schenectady, N. Y. Bulletin GEA-482A, describing the manufacture and applications of "Fabroil" and "Textolite" silent gears. The bulletin gives recommended practice for machining "Fabroil" and "Textolite," and contains tables of dimensions of gear blanks made from these materials.

TUMBLING AND PICKLING BARRELS. Ideal Industrial Machinery Division of Consolidated C. M. Corporation, Winton Place, Cincinnati, Ohio. Catalogue illustrating and describing "Ideal" industrial machinery for tumbling, separating, cleaning, washing, burnishing, painting, and pickling metal parts. Actual installations of these machines in various plants are shown.

ELECTRIC MEASURING INSTRUMENTS. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Bulletin 434, entitled "Students' Kelvin Bridge," describing an instrument for teaching the Kelvin bridge method of measuring low electrical resistances accurately. Bulletin 500, treating of the automatic control of acid baths by the use of Leeds & Northrup recording controllers.

BUTT-WELDING MACHINES. Federal Machine & Welder Co., Dana Ave., Warren, Ohio. Bulletins 80 and 82, illustrating and describing in detail two types of Federal automatic butt-welding machines. In addition to the description of these machines, illustrations are included, showing typical installations for the high-speed production of automobile and agricultural rims and similar work.

INDUSTRIAL TRUCKS. Stuebing Cowan Co., Cincinnati, Ohio. Pamphlet entitled, "Straight Line Trucking," describing the use of the Stuebing Cowan lift truck platform system on railroads and other transportation companies. The illustrations show the use of these trucks in handling materials in the stores department and machine shops and handling freight at railroad and steamship terminals.

NICKEL CHROMIUM ALLOY. Southern Manganese Steel Co., St. Louis, Mo. Pamphlet descriptive of the characteristics and application of "Fahralloy," a chrome nickel alloy, which is made in thirteen grades for various classes of work requiring maximum resistance to heat and corrosion. Circular illustrating various products for which "Fahralloy" is suitable, including furnace shafts, carburizing boxes, retorts, chains, etc.

CLEANING MATERIALS. E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa. Pamphlet entitled, "'Houghto-Clean,' for the Metal Industries," outlining the uses of "Houghto-Clean" cleaning materials for metal-working plants. The pamphlet describes different methods of applying cleaning materials, and the use of these materials in power plants, automobile service stations, railroad yards, the oil industry, and general industrial plants.

PORTABLE LIGHTING EQUIPMENT. Bart Mfg. Co., 6001 S. Talman Ave., Chicago, Ill. Bulletin illustrating different styles of Bart portable lamps for use in garages, service stations, and industrial plants, including machine or bench lamps, floodlight lamps, and heavy-duty hand lamps. Two handy tools for the mechanic's kit, illustrated in this bulletin, are the Bart solder pot for carrying melted solder, and a valve key tool for extracting and inserting all types of valve keys or pins.

BELT DRIVES. L. H. Gilmer Co., Tacony, Philadelphia, Pa. Handbook of small belt drives, discussing the use of belts of rubber and cord fabric for power transmission, with special reference to the application of V-belts to short-center and high-speed drives. Engineering data are given for use in designing V-belt drives, and numerous illustrations show Gilmer belts on a wide variety of machines. The book will be sent without charge to executives who are interested in this subject.

ELECTRIC EQUIPMENT. General Electric Co., Schenectady, N. Y. Bulletin GEA-78A, illustrating and describing crane and hoist motors. Bulletin entitled "Electric Heat in General Electric Factories," illustrating electric ovens, furnaces, and other types of heating equipment installed in General Electric factories. Bulletin GEA-61B on constant-speed direct-current motors. Bulletin GEA-844A on magnetic reversing switches. Bulletin GEA-1059 on two-frame and four-frame motor drives for textile mill service.

THREADING HEADS AND TAPS. Landis Machine Co., Waynesboro, Pa. Catalogue 30, covering the complete line of Landis thread-cutting die-heads and Victor taps. The catalogue contains specifications for the "Land-Matic" head for turret lathes and screw machines; the "Landex" head for automatic screw machines; the "Lanco" head for automatic, semi-automatic, and hand-operated threading machines, as well as for collapsible, adjustable and special taps. Information is included on the care and operation of these tools.

ELECTRIC MOTORS. Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo. Bulletin describing Wagner large RA single-phase repulsion-induction motors. The bulletin comprises a treatise on single-phase motors in general, covering such subjects as type of single-phase motors; history of the repulsion-induction motors (from the first hand-cranked motor to the present self-starting type); operating principles, with torque-speed-current curves and cross-sectional diagrams of the motor; sleeve and ball bearing construction; ventilation and construction features of stator, end plate, rotor, and rocker arm.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly at New York, N. Y., for October 1, 1928.

State of New York } ss.
County of New York }

Before me, a Notary Public, in and for the state and county aforesaid, personally appeared Edgar A. Becker, who, having been duly sworn according to law, deposes and says that he is the treasurer of the Industrial Press, Publishers of MACHINERY, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, The Industrial Press, 140-148 Lafayette St., New York; Editor, Erik Oberg, 140-148 Lafayette St., New York; Managing Editor, None; Business Managers, Alexander Luchars, President, 140-148 Lafayette St., New York, Robert B. Luchars, Vice-president, 140-148 Lafayette St., New York, and Edgar A. Becker, Treasurer, 140-148 Lafayette St., New York.

2. That the owners of 1 per cent or more of the total amount of stock are: The Industrial Press; Alexander Luchars; Alexander Luchars, Trustee for Helen L. Ketchum, Elizabeth Y. Urban, and Robert B. Luchars; Nellie I. O'Neill; Louis Pelletier; and Erik Oberg. The address of all the foregoing is 140-148 Lafayette St., New York.

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Sworn to and subscribed before me this 1st day of October, 1928.

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(My commission expires March 30, 1929.)